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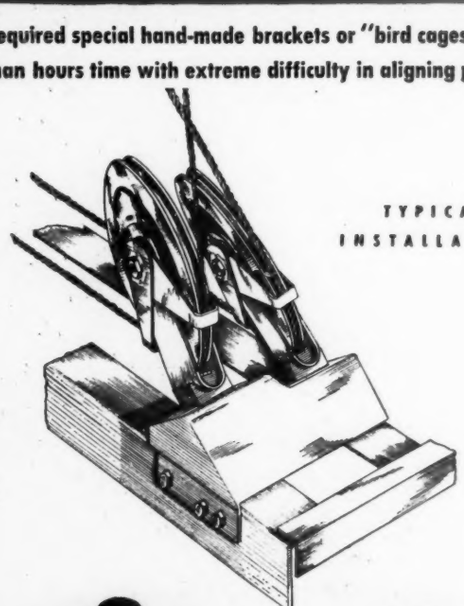

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AVIATION

NUMBER 11 VOLUME 42

NOVEMBER, 1942

Contents

In This Issue 5
Editorial Page 91
AVIATION's War Communique No. 11 92
Aircraft Industry in All-Out Cooperation 94
Factors Controlling Aircraft Design and Combat Performance — Maj. Nathaniel F. Silsbee, AAF 96
Stepping Stones to Action: Trainer Silhouettes 100
Meteorological Characteristics of Thunderstorms, Part II — George N. Brancato 101
Proper Feeding Boosts Worker Production — Lucius S. Flint 104

Aviation Manufacturing

Production—Design—Research—Engineering — Complete Index 107
Wood Techniques Developed in Glider Construction 108
Developing Graphic Illustrators — R. R. Wiese 113
Design Considerations for Plywood Structures — L. J. Marhoefer 114
Range of Drop Hammer Operations — Chris J. Frey and Stanley S. Kogut 118
The Future of Water-Based Airplanes, Part VI — Capt. Frank T. Courtney 122
SAE Holds Aircraft Production Meeting 124
Tool Design Gains Importance — John J. Scheppe 129
Fabricating Plastic Dies for Acrylate Sheets — Kenton S. Leeg 143
Review of Patents — A. Harry Crowell 153
AVIATION's Sketch Book of Design Detail 154
AVIATION's Engineering Data Book 161
Factory Maintenance Section: Maintaining Arc Welders for Peak Production — R. F. Wyer 133
Subcontractors Section: Subcontracting Practices at United Aircraft 189

New Products

Information Tips on Timely Aviation Topics 164
Modern Machine Tools 165
Shop Equipment and Accessories 168

Military

Guardians of the Convoys — Esther H. Forbes 197
Fire Power Details of Nazi Planes 200

Maintenance

Importance of Piston Rings in Aircraft Engine Maintenance — Paul S. Lane 205

Air Transport

Air Cargo Will Expand World Trade — George F. Bauer 213
Financing the Airlines — Selig Altschul 219

Flying Equipment

Design Details of the BMW801A Engine — Myles V. Cave 228

Civil Operation and Training

Simplified Computers Aid Navigation — Lt. Comdr. P. V. H. Weems 233
On Patrol 237
Along the Apron 237

Side Slips 195

The Aviation News

National Aviation 243
Washington Windsock 247
Calling Names 248
Aviation Manufacturing 251
Assembly Lines 252
Transport Aviation 255
Aviation Abroad 261
Finance — *By Raymond Hoadley* 267
Aviation People 265
Book Reviews 271

George W. Pfeil ..... *Publisher*
Leslie E. Neville ..... *Editor*
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On Leave of Absence With Government Services

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Jay P. AuWerter ..... *Lieut., Air Forces*
Randolph Hawthorne ..... *Lieut., Air Forces*
Kenneth D. Reynolds ..... *Lieut., Infantry*
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Where every POUND of fuel counts...

OVER increasingly greater distances each succeeding day range big American bombers. In spite of rough weather and adverse winds, objectives *must* be reached. From every pound of fuel the pilot must extract every ounce of power. Hence the use in long-range craft of the "PIONEER" Fuel Flow Meter. This high-precision instrument tells the pilot at all times the *exact* rates at which his motors consume fuel . . . enables him to adjust each mixture control for maximum operating efficiency.

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★ ★ ★ ★ ★ ★ ★ ★ ★ IN THIS ISSUE

FOLLOWING up the several articles in the October issue giving the truth about our warplanes—articles which have been quoted by press and radio commentators from coast to coast—AVIATION this month presents an authoritative analysis of the factors controlling aircraft design and combat performance (page 96). This study by Maj. Nathaniel F. Silsbee of the Army Air Forces gives heretofore unrevealed performance figures and design features and presents a clear refutation of much of the unfounded criticism which has been leveled at American aircraft. Every military plane is a compromise, but Maj. Silsbee shows how American designers have done an outstanding job of compromising on the right factors. His report is both sound and encouraging.

Cooperating for Victory

Some of the reasons behind the miraculous production job done by the aircraft industry are revealed for the first time in an exclusive AVIATION survey (page 94) of cooperative ventures which today are the rule rather than the exception. This study shows how one-time competitors are not only lending each other vitally needed materials, but how they are trading invaluable "know-how," lending each other engineers and technicians—even giving design and production secrets to competitors to keep the production lines rolling at a faster pace.

In presenting Design Considerations for Plywood Structures (page 114), AVIATION begins an authoritative series by L. J. Marhoefer, an outstanding plastic bonded plywood design engineer. His approach to the problem is completely fresh; he treats plastic bonded plywood design as it should be treated —as a different technique rather than a mere adaptation of metal working practices.

Glider Construction

One of the greatest problems in developing America's glider program was to build the motorless carriers without cutting into the critical material supply of the industry. Just how it is being done, and how quality is being maintained with quantity, is told in the article on Wood Techniques Developed in Glider Construction, beginning on page 108.

In the concluding article of his series on the Future of Water-Based Planes (page 122) Capt. Frank T. Courtney shows why a new approach to the problems of designing such craft is essential to give them performance comparable to land-based planes. It is inevitable, he points out, that water-based planes *will* equal land-based planes in performance; it is essential that such results be achieved first in this country if we are to maintain our qualitative superiority in aircraft development.

Drop Hammer Operations

New techniques which widen the scope of usefulness of drop hammers are presented to AVIATION's readers (page 118) by Chris J. Frey of Brewster Aeronautical Corp. and Stanley S. Kogut of the Eastern Aircraft Production Forum.

AVIATION this month inaugurates a new regular feature: its Factory Maintenance Section (page 133), opening with a practical, down-to-earth study on the maintenance of arc welders by R. F. Wyer. The equipment maintenance section this month features the importance of piston rings (page 205), in which Paul S. Lane gives hows and whys of practices leading to better engine performance.

In the military field, Myles V. Cave, AVIATION's British correspondent, presents a detailed description of design features of Germany's BMW-801 engine, the most advanced aircooled powerplant put into production by the Nazis and the forerunner of the 2,000-hp. 802 which is just beginning to make its appearance.

Fire Power of Nazi Planes

Also in the sphere of foreign military aircraft, AVIATION reveals fire power details of German planes. This excellent "companion piece" to Maj. Silsbee's article illustrates the protective fire screen of four Luftwaffe "workhorses" and exposes their vulnerable spots.

Lt. Comdr. P. V. H. Weems, outstanding authority on navigation, explains the advantages of new simplified computers (page 233) for both military and civilian navigators, illustrating their use by actual problems.

George F. Bauer, author of "Air Cargo Will Expand World Trade" (page 213), was for 20 years export manager of the Automobile Manufacturers Association and, as such, directed campaigns in 84 countries. He initiated the World Trade League, work for which he was praised by both President Roosevelt and Secretary of State Hull. An inveterate traveler, he has had many opportunities to follow closely the developments in air communications throughout the world, having flown in Europe and South America as far back as 1924 and in Africa as early as 1929.

Coming

Bigger than ever before, AVIATION's Annual December Maintenance Issue next month will bring a wealth of new and useful information on maintenance practices and procedures to America's military and civil operators of aircraft.

Maintenance of American Aircraft Abroad, Manpower Problems in Maintenance, Preventive Maintenance for Safety and Military Field Maintenance are but a few of the subjects which will be covered by recognized authorities in their fields.

The editors of AVIATION are scouting the maintenance bases, military depots, shops and factories over the length and breadth of the country to report first hand to the industry on the newest and best practical innovations for better and faster maintenance. Numerous sketches, drawings and photographs will be presented illustrating efficient workstands and benches, hoists and shop equipment such as jacks, dollies, racks and special jigs and fixtures for engines, accessories and other aircraft components.

Also, watch for announcement of the winners of AVIATION's coveted Annual Maintenance Award.

Their roots are sprouting SYNTHETIC RUBBER 10,000 miles away

Thousands of rubber trees have been destroyed in the Far East; it will take years to regrow them. Japan can't hold the rubber groves and the huge raw rubber stocks she has seized, so she probably will destroy them. These dark clouds have a silver lining in synthetic rubbers—made wholly in America, totally by American labor, and serving all America better than tree rubber ever did.

Hycar synthetic rubbers were being produced long before Pearl Harbor. But the war, shutting off the supply of crude rubber, was a stimulus that is bringing astonishing results in chemical research and production of Hycar synthetic rubbers that are vastly superior to tree rubber.

Of course, rubber stocks must be zealously conserved. The needs of the United Nations are tremendous. They get first call on every existing scrap of rubber and on every pound of synthetic rubber produced.

Hycar laboratories are ceaselessly exploring, testing, and developing new formulas and processes. Hycar synthetic rubbers are being manufactured that have marked superiorities over tree rubber and many plastic products. Some of these advantages are better tensile strength and electrical properties; greater resistance to age and harmful effects of oxygen, sunlight and heat.

Certain Hycar compounds, though light in weight and impervious to oil, withstand severe flexing—a combination particularly valuable in bombers and fighting planes. Other Hycar types have unusual resistance to abrasion, a property highly desirable in tires and tank tracks.

Hycar is a raw material furnished to manufacturers of finished rubber products. Your rubber supplier can explain Hycar's advantages. If you are producing a war essential, our chemists and engineers will be glad to cooperate and help on rubber problems. HYCAR CHEMICAL COMPANY, Akron, Ohio.

With Hycar in a Plane, There's More Pay Load

Hycar is saving so much weight in many planes that armament or bomb load can be increased. Hycar gives you strength, resistance to oil and abrasion, ability to withstand heat and cold and compression-set—all with *less weight*. Let Hycar help you increase the real pay load of your planes.

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LARGEST INDEPENDENT PRODUCER IN AMERICA OF BUTADIENE SYNTHETIC RUBBER

Construction—Builder of Bases

America's Great Peacetime Industry Goes to War

PUNCHED through 1,600 miles of trackless wilderness and rivaling the Panama Canal in strategic importance, the Alaska Highway will cut days and dangers from present supply routes . . . to Alaska . . . to the Aleutians . . . yes, to Japan itself!

This job, to be finished soon and well ahead of schedule, is but one example in thousands illustrating how construction sets the stage for our war effort . . . and why the construction engineer is vital to victory.

Back of America's busy production lines, expanding shipyards, growing cantonments and far-flung military bases is a series of swiftly executed construction jobs. Important jobs! ***For the construction industry is a builder of bases. Bases for production—for training—for defense—and for attack.***

To conceive and to carry through so tremendous a program in a race against time is typically American. It requires enterprise and the sort of versatility that has been acquired by undertaking every kind of job; from a Boulder dam to a drydock, from a Pennsylvania Turnpike to a housing project, from a Radio City to a railroad tunnel . . . and taking it in stride. War's demands in the eyes of America's construction men, are simply more of the same—for a grimmer purpose, and under heavier pressure.

The civil engineers who develop the necessary designs, the contractors who execute them and the manufacturers who provide the equipment and materials, are as much a part of this war as are the men who face the enemy. The results of their labors are recorded in mounting production figures, and will be indelibly written in the military annals of this war. Those 60,000 airplanes, 45,000 tanks and 8,000,000 tons of shipping that the President asked for in 1942 will be supplied because—and only because—the construction industry did a Herculean plant-building job first—and fast.

This is the fifth of a series of editorials appearing monthly in all McGraw-Hill publications, reaching more than one and one-half million readers, and in daily newspapers in New York, Chicago and Washington, D. C. They are dedicated to the purpose of telling the part that each industry is playing in the war effort and of informing the public on the magnificent war-production accomplishments of America's industries.

Yes, construction, America's great peacetime industry, has gone all out for war. From a normal 6½ billion dollars in 1938, it got into its war stride last year with a 11½ billion dollar volume. And under the impetus of Pearl Harbor, the 1942 figure now promises to reach the unprecedented total of 15 billion dollars. "If buildings would win the war, Hitler would be licked now", said Lieut. Gen. William S. Knudsen recently. Which emphasizes the further fact that the construction industry was the *first* to go to war.

The technical and managerial talent that is accomplishing this mammoth job has had to find its strength and resources within itself. No possibility of "conversion" here! Only years of varied construction experience enabled it to tackle and to achieve the manifold tasks that building for war demands.

Take that cornfield, for instance, that Henry Ford picked for his record-breaking bomber plant. The spring mud was soft and deep when contractors moved in last year. They were entering a race against an almost impossible time limit. Before they could even begin on the plant itself, they had to build roads, lay a 4-mile water supply line and install a complete sewerage system with its disposal plant. But such varied jobs—each big in its own right—merely were antecedent to running up the framework and enclosure for the 60-acre factory itself. Or to using road-building methods to pave a floor that was the equivalent of 25 miles of 20-foot wide concrete highway.

It was a race against the approaching winter, and to win it they had to push their $1,000,000 worth of construction equipment to the limit—day and night. But win they did! It is accomplishments like these that explain how the nation's aviation factory floor space jumped from 18,000,000 to 60,000,000 square feet in

the past two years . . . why Fortresses and fighter ships are beginning to turn the scales of war in our favor.

"Somewhere in the Southwest" the Army called for a training base. The contractor who answered that call summed up his performance in characteristic fashion: "Beginning without so much as a contour map we had a $10,000,000 project ready for operation within 90 calendar days, and saved 3½ million dollars of the estimated cost".

At another Army camp a contractor assembled a crew of 20,000 men who put together 1,400 buildings in 125 working days, along with a sewer system, a water-supply and a street layout of which many a fair-sized city might be proud. This job swallowed up 2,000 carloads of lumber, and 26,000 kegs of nails. So perfect was the teamwork, from the general manager down through the hundreds of superintendents and foremen to the specialized crews, that as many as seventy buildings were erected in one single day.

But versatility and experience are not the only qualities that the construction engineer has in his tool chest. He has ingenuity, and he needed it when steel, copper, zinc and aluminum had to be used for combat equipment, and were denied him. Great hangars, conventionally of structural steel, were turned out with record-breaking timber arch spans. Reinforced concrete factories were designed to require only 3 lb. of steel bars per square foot instead of the customary 5 lb. Asphalt-impregnated paper was substituted for copper in flashings, cement-asbestos for galvanized steel in duct work. In the face of a materials shortage, he continued to build bases—safely, economically, and on time.

Construction ingenuity, too, is back of the records in Liberty ships, in war housing and a host of other facilities. Indeed, it was the construction industry that stepped forward to assume the bulk of the emergency shipbuilding program, leaving established yards free to handle more specialized Navy work. Naturally, it was easy for civil engineers and contractors to build the shipyards, but building ships was another story. It is a far cry from steel ships to conventional engineering structures, yet, drawing upon their bridge and building experience, the men of construction have turned out ships faster than they were ever built before.

How was this possible? . . . because the construction man sees every job as a new problem, views every precedent as something to be discarded in favor of something better. So instead of assembling the myriad separate pieces of each ship on the ways, he fabricated them into huge built-up sections. These he swung to the ways and welded them into place in a fraction of the time required by old methods.

Again, the demands for wartime housing for workers in industrial areas, at Navy bases, and near Army concentrations, have altered the meaning of "residential construction". The building of individual houses has given way to a form of multiple-unit project that calls for the skilled services of the architect, the civil engineer and the large contracting organization. On one such project, for example, a contractor experienced in large building and bridge construction employed an extensive system of prefabrication and site assembly that made possible the completion of 5,000 houses for war workers within five months.

All these activities, within the United States, parallel the achievements of other industries that serve the men at the front. But construction knows no continental limits. Its men are serving throughout the network of defense bases built in the West Indies, Greenland, and Iceland, and in the offensive bases that are taking form in the jungles and deserts of Africa, the harbors of the Persian Gulf, and the plains and mountains of Australia and Alaska. Already in this war, as in the last one, construction crews, like those at Wake and Guam, have dropped their peacetime tools to fight shoulder to shoulder with their comrades in uniform. Construction follows the flag to the farthest outposts in this global struggle.

* * * *

But while the construction industry thus serves the special needs of the armed forces, it must look after its job at home. It must keep the highways serviceable, the water supply safe, sanitary facilities adequate. There are home chores that cannot be neglected even in war.

And when we finish our No. 1 task of winning the war, the construction industry will again be called upon to help re-establish peacetime employment and to stimulate the normal industrial activities of the nation. It will raze, redesign and rebuild; it will bring modern sanitation to urban dwellers; it will safeguard fertile areas and cities from disastrous floods; it will improve all forms of transportation; it will design and build the facilities that will be needed to reconvert from war to peace. Its vision, versatility, experience and ingenuity will be as indispensable then as they are vital now.

Today it is building the bases that are needed back of every battle-line. Tomorrow it will build for a new and better era. Today it is laying the foundation for the victories that must be ours. Tomorrow it will lay the foundation for the peace that will follow these victories. In war and in peace the construction industry is the builder, the harnesser of nature's forces.

President, McGraw-Hill Publishing Company, Inc.

The Pattern of the Peace

ALMOST EVERYONE who looks beyond the tip of his nose is conscious of the fact that we should do some thinking about the postwar period now. But too many are too afraid that they will be criticized if they admit that they are devoting any thinking time to anything but the Herculean task in hand. Unfortunately, this is particularly true of the aviation industry, which has been criticized wrongfully so much and so often that it is gun shy of criticism and investigation.

If we look beyond our own industry we will see no such fear of criticism. Every great industry is thinking freely of the future. The President of the United States and the Prime Minister of Great Britain gave the world a postwar blueprint in the Atlantic Charter. The Vice-President of the United States has gone on record as an advocate of postwar planning. Already federal agencies and committees are at work on the problem. It behooves all the members of the aviation industry to follow their example.

At the risk of sticking our neck out too far we present several elements of the postwar picture—a partial outline of some of the things we should be thinking about while shaving or while waiting for an airline seat priority to come through:

1. As long as there are men who aspire to rule the world by force, and there always will be, some means must be provided to keep them in check. No means could be more effective in keeping order than properly directed air power. We must guard against the temptation to terminate our military strategy when the armistice is signed. We must create a community of nations with aeronautical teeth to enforce their arbitration. This is a duty not only as members of the industry, but as citizens of the new and better world for which we are fighting.

2. Lines of communications in war inevitably become trade routes in the peace that follows. Our airlines, foreign and domestic, were ready for the next step in their growth when this war came. The war has shortened the time for development of world airways by many years. We must take full advantage of this accelerated progress. Hourly service between New York and London and other miracles of transportation will be realities before the war ends. We must readjust the tempo of our thinking to the new tempo of business that this and other international airlines services will make possible.

3. Our domestic trunk line airways were highly developed when this war was thrust upon us. With the flying equipment developed during the war, our airlines will be able to move forward to non-stop high altitude transcontinental passenger, mail and express service and consolidate this service with intermediate feeder operations and local second-class services for passengers and goods whose journeys do not demand the urgency of first-class service. The technique of air mail pickup and delivery by planes in flight has been perfected and will be used to provide air mail and express service to the smallest villages. The efficiency and flexibility of glider trains will reduce costs and broaden service.

These facilities will contribute their part to the solution of the problem of distribution which must be solved if we are to take full peacetime advantage of the production machinery developed for this war. And that productive capacity we are creating is so great that it will absorb not only the air services but existing ground transportation facilities for proper distribution of its products.

4. The pilots we are training for our armed forces are tomorrow's business men. They will not be content to return to the old tempo of travel. They will demand personal airplanes for their business and their pleasure. Those who do not own their own ships will demand fly-it-yourself services. Airplane distributors and dealers must not let their sales ability soften in this era of easy business or they may find sharp competition from the automotive ranks in the postwar period.

5. Automobile makers who aspire to be airplane manufacturers should realize that their best production efforts will be worthless if they are not supported by adequate design facilities, or affiliation with well-developed design organizations. Airplane makers who have ambitions in automobile manufacturing must realize that customers will not beat a path to their doors. No matter how attractive their postwar products may be, they will not sell themselves.

There will be no middle course between poverty and prosperity after this war. If we fail to adjust our sights to the opportunities that lie ahead we will fail miserably. If we find the ways and means to distribute the goods we know we can produce, the world will be a better place to live in than it ever has been before. We must approach the distribution problem with the same determination we have demonstrated in the miraculous job we have done in producing the wherewithal to win the war. In this aviation will play a tremendously important part.

Leslie E. Neville

AMERICA AT WAR

Amazing record being established by United States heavy bombers shows our strategists and designers were right from the beginning—to the delight of the British and chagrin of the Nazis. But, while United Nations' airpower gains strength at encouraging rate, we still have a long way to go to win the war.

MAJ. GEN. IRA C. EAKER, chief of the United States Bomber Command in Britain, says German industry can be destroyed from the air. The House Military Affairs Committee, after investigation, says American airplanes are far superior to those of the enemy. The battleship admiralty of England launches two more iron sea horses while navies fight in the air almost exclusively. Goering, in an epochal speech, admits that his Luftwaffe is powerless just now to resist the blows of Allied air power, but he still promises to even the score when Russia is in the bag.

There you have a few scenes in the fast-moving world air war drama of recent weeks. There were still other vital developments. The United States launched a new aircraft carrier *Lexington* to replace her predecessor, and with this launching came news that the *Yorktown* also had gone down after killing many times her weight in enemy planes and ships, including three Japanese carriers sunk and one damaged, which was later sunk.

The Army occupied the Andreanof Islands, only 150 mi. from bases seized last summer in the Aleutians, and went to work on the enemy with B-17's, B-24's, P-38's, P-39's, and P-40's. It was the beginning of a drive to push the Nipponese off the island causeway, which we may want to use as our own road to Tokyo when the time comes.

Probably most inspiring to airmen and pro-airmen was the continued story of the combat performance of Boeing B-17 *Flying Fortresses* and, more recently, the Consolidated B-24 *Liberators*. Many are surprised, including the British who had made up their minds that heavy night bombing was the key to the iron gates of Europe. Not the least surprised were the Nazis. Your correspondents have a well-founded report that a German radio message was intercepted which said that the Luftwaffe was at a loss for means to stop the *Fortresses*.

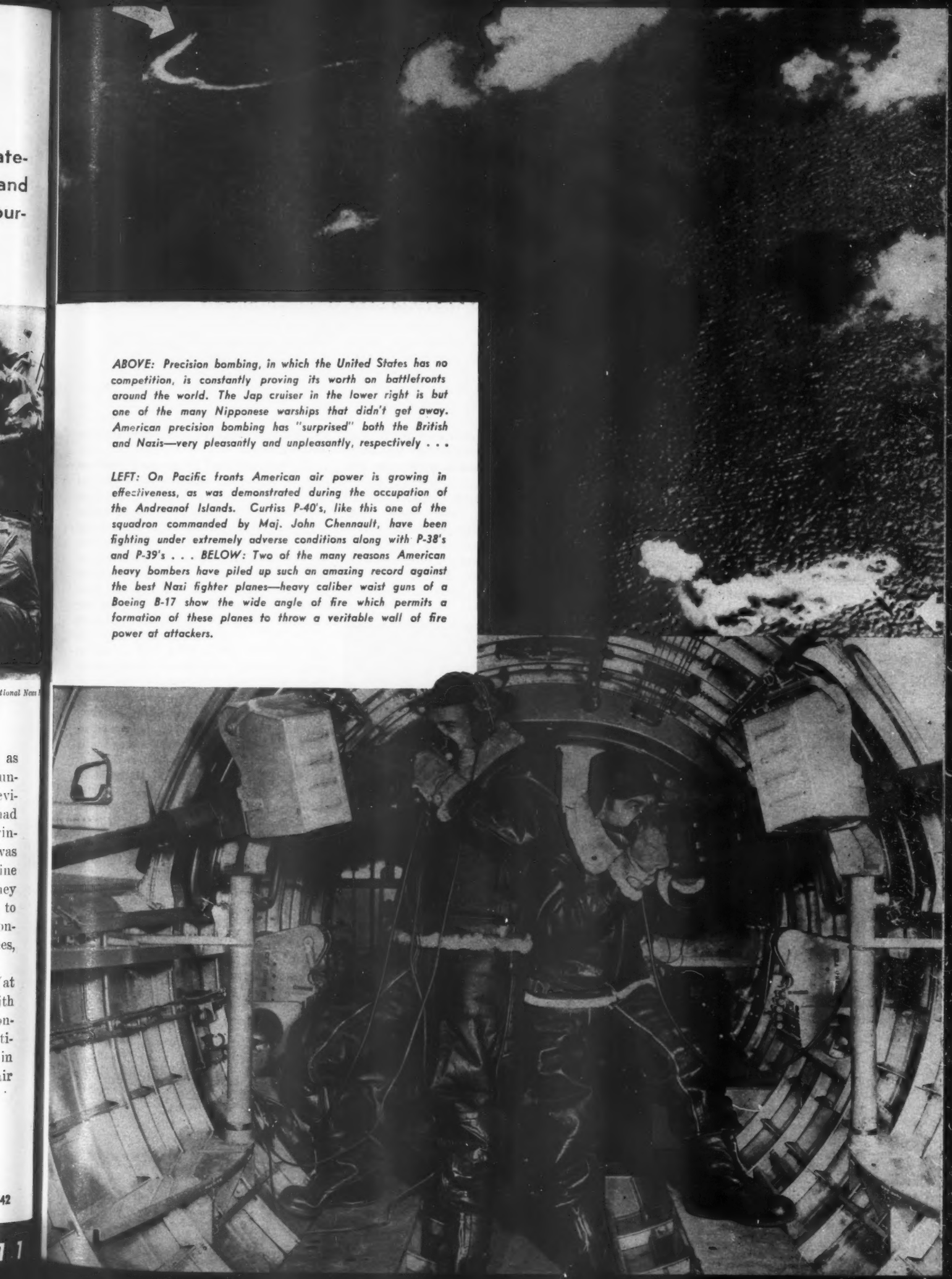
Details of B-17 exploits are widely reported in the news, but not generally emphasized is the fact that Boeing engineers have been "heavy" designers since the company's beginning. You may recall that the first postwar fleet of transport planes to operate in this country were the Boeing 40 series of single-engine pas-

International News

senger-cargo ships. They managed to be heavy and as rugged as a hickory wagon, yet they got over the mountains with a good load—more than double what previous planes of about the same power (425 hp.) had carried. They never wore out, and neither did the twin-engine 247's that came after them. Incidentally, it was the "40" series that proved out the aircooled engine for "dependable" operation, as the Pratt & Whitney people say on their name plate. All that wordage is to give background for the reason why the enemy is astonished to find that he can shoot the *Fortress* to pieces, but the pieces don't fall apart.

The B-17's—together with B-24's—have made (at this writing) well over 100 sorties over Europe with little loss and are threatening some of the prime concepts of air war. It has been supposed that multi-engine load-lifting combat planes could not survive in daylight against darting fighter gadflies. But the air warriors are beginning to wonder.

(*Turn to page* 275)



ABOVE: Precision bombing, in which the United States has no competition, is constantly proving its worth on battlefronts around the world. The Jap cruiser in the lower right is but one of the many Nipponese warships that didn't get away. American precision bombing has "surprised" both the British and Nazis—very pleasantly and unpleasantly, respectively . . .

LEFT: On Pacific fronts American air power is growing in effectiveness, as was demonstrated during the occupation of the Andreanof Islands. Curtiss P-40's, like this one of the squadron commanded by Maj. John Chennault, have been fighting under extremely adverse conditions along with P-38's and P-39's . . . BELOW: Two of the many reasons American heavy bombers have piled up such an amazing record against the best Nazi fighter planes—heavy caliber waist guns of a Boeing B-17 show the wide angle of fire which permits a formation of these planes to throw a veritable wall of fire power at attackers.

AIRCRAFT INDUSTRY IN ALL-OUT COOPERATION

AVIATION's survey shows that peacetime prejudices and rivalries are overboard for the duration; aircraft, engine and parts manufacturers are cooperating fully with Government, Army and Navy, United Nations, licensees, subcontractors and others by exchanging men, ideas, formulas and materials in unprecedented teamwork to speed the war effort.

"BUSINESS AS USUAL" is out for the duration. But nowhere in American business or industrial life has so much progress been made toward winning the war by discarding peacetime prejudices and rivalries as in the aircraft industry. This is apparent as the result of a comprehensive survey just completed by AVIATION in which aircraft manufacturers from coast to coast were questioned to determine the extent to which they and their one-time rivals had dropped normal competition to join a unified force dedicated wholly to victory.

The story is one of cooperation and coordination which has never been matched by any other industrial group in American history. For the normal competitive practices of our system have been scrapped first to win the war and, second, to insure their reestablishment as basic democratic principles after victory.

To attain maximum warplane production as quickly as possible by the free exchange of engineering data, research, manufacturing technique, facilities, materials and personnel, eight Eastern aircraft manufacturers have formed the Aircraft War Production Council, East Coast, Inc. Seated, left to right: Glenn L. Martin, president, Glenn L. Martin Co., vice-president of council; G. W. Vaughan, president of Curtiss-Wright Corp., and head of the newly formed cooperative group; and Victor Emanuel, president, the Aviation Corp. Standing, left to right: O. L. Woodson, vice-president, Bell Aircraft Corp.; R. S. Damon, president, Republic Aviation Corp.; J. Carlton Ward, Jr., president, Fairchild Airplane & Engine Corp.; L. C. Goad, general manager, Eastern Aircraft Division of General Motors Corp.; and George Chapline, vice-president, Brewster Aeronautical Corp.

Individually and in groups, members of the aircraft industry have joined hands with one another and the government to exchange methods of training personnel, systems of producing any product better and faster, loaning materials to aid one-time rivals over acute shortages, exchanging laboratory analyses and engineering data once jealously guarded and subcontracting for thousands of parts and assemblies developed wholly and with pride in plants which normally would expect to produce them and thereby gain their reward.

The most recently formed group of aircraft manufacturers to pool their combined resources of engineering, research, manufacturing technique, facilities, materials and personnel is the Aircraft War Production Council, East Coast, Inc. Headed by G. W. Vaughan, president of Curtiss-Wright Corp., this organization comprises the Aviation Corp., Bell Aircraft Corp., Brewster Aeronautical Corp., Eastern Aircraft Division of General Motors Corp., Fairchild Airplane & Engine Corp., Glenn L. Martin Co., Republic Aviation Corp., and Curtiss-Wright. Other companies are expected to join shortly.

"It is the object of these companies who comprise the council," Mr. Vaughan says, "to work as a team rather than as individuals, to coordinate all work for the war effort, to freely exchange information, engineering data and manufacturing processes that would be regarded in normal times as secret and to pool mutual interests and facilities thereby assuring maximum aircraft production as quickly as possible. Once we accomplish this, we shall be taking a very significant step in increasing America's warplane output.

"The American aircraft manufactur-

ing industry has in the past three record-breaking years caught up with and exceeded the combined aircraft production of the Axis nations. With this new council and our associate organizations on the West Coast in action, we expect to more than meet the plea of Donald Nelson and the War Production Board that we 'produce more . . . faster . . . '"

Another major group of aircraft manufacturers eliminating bottlenecks in production by cooperative exchange of once private information is the Aircraft War Production Council, Inc. This previously formed association comprises Consolidated, Douglas, Lockheed, Northrop, North American, Ryan, Vega and Vultee as aircraft manufacturers operating in Southern California. In one recent month, nearly 2,000 potential bottlenecks in warplane production were averted in these eight plants by the free interchange of engineering reports and, on loan or on sale basis, material needed to keep production going at full speed. In the same month, there were 1,557 such exchanges of material, 132 engineering reports and 171 library references to technical reports.

A breakdown of the material exchanges by members of the council reveals that 15,390 lb. of rivets were either loaned or sold to insure no interruption in assembly lines. Other items exchanged included: 2,800 cotter pins, 9,889 bolts, 42,605 nuts, 26,459 screws, 2,000 ft. of webbing, 551 turnbuckles, 900 bushings, 3,400 ft. of conduit wire, 3,310 bearings, 300 welding rod electrodes, 2,000 nut plates, 60 spiral drills, 17,983 ft. of copper tubing, 3,520 gaskets, 460 speed controls, 8,530 ft. of brass wire, 8,400 shaft assemblies, 9,015 fixed cowl components, 6,567 ft. of steel bar, 6 motors, 24 blue fluorescent lamps, 6,100 ft. of zinc chromate tape, 42 castings, 2,000 lb. of sheet steel, 1,402 ft. of steel tubing, 5,000 curtain fasteners, 1,250 terminals, 25,000 ft. of electric cable and hundreds of other items.

Among the important exchanges of engineering reports were those dealing with adhesion of Neoprene to Plexiglass, air sealing of single row screw seams, molded plastic cockpit and gunners' enclosures, radio background interference, windshield de-icing, ground fuel system test with aromatic fuel, urea formaldehyde resin glues, spot welding of magnesium alloys, lubricants for double-acting press and drop hammer forgings.

Because of this unparalleled exchange of vital information, under Army and Navy supervision, substitution of plastics and plywood in one type of warplane is now saving as much as 1,000 lb. of strategic aluminum per airplane, according to the council. The eight members of the West Coast group are steadily comparing notes on how other strategic materials may be saved by substitution of more easily obtained metals, woods or fabrics.

Still another similar organization has been formed with J. T. Thompson of the Glenn L. Martin company as chairman of the Eastern Seaboard Standards Committee of the Aircraft Industry. Its function is to further the free exchange of ideas, formulas, standard parts, extrusion dies and other factors involved with uninterrupted production of warplanes. The success of the Eastern Seaboard Standards Committee matches that of the Production Councils as all have the same objectives.

Another link was forged in the common effort to expedite war production when two powerful American industries —the aircraft manufacturers and automotive builders now engaged in producing airplanes and engines—formed a joint transportation unit known as the Aircraft War Traffic Conference. Like other organizations created by the aircraft industry in its 100 percent effort to win the war by cooperation, the new conference is serving as a clearing house for research, interchange of experience, technique and information on all kinds of aircraft traffic, loading and shipping, rates, classification, bills of lading, routing and other transportation factors.

The Aircraft War Traffic Conference, headed by W. J. Goehausen, traffic manager of the airplane division of Curtiss-Wright Corporation, also is presenting the views of aircraft "automotive" manufacturers to interested governmental agencies, the Army and Navy air forces and other groups charged with winning the war in the air.

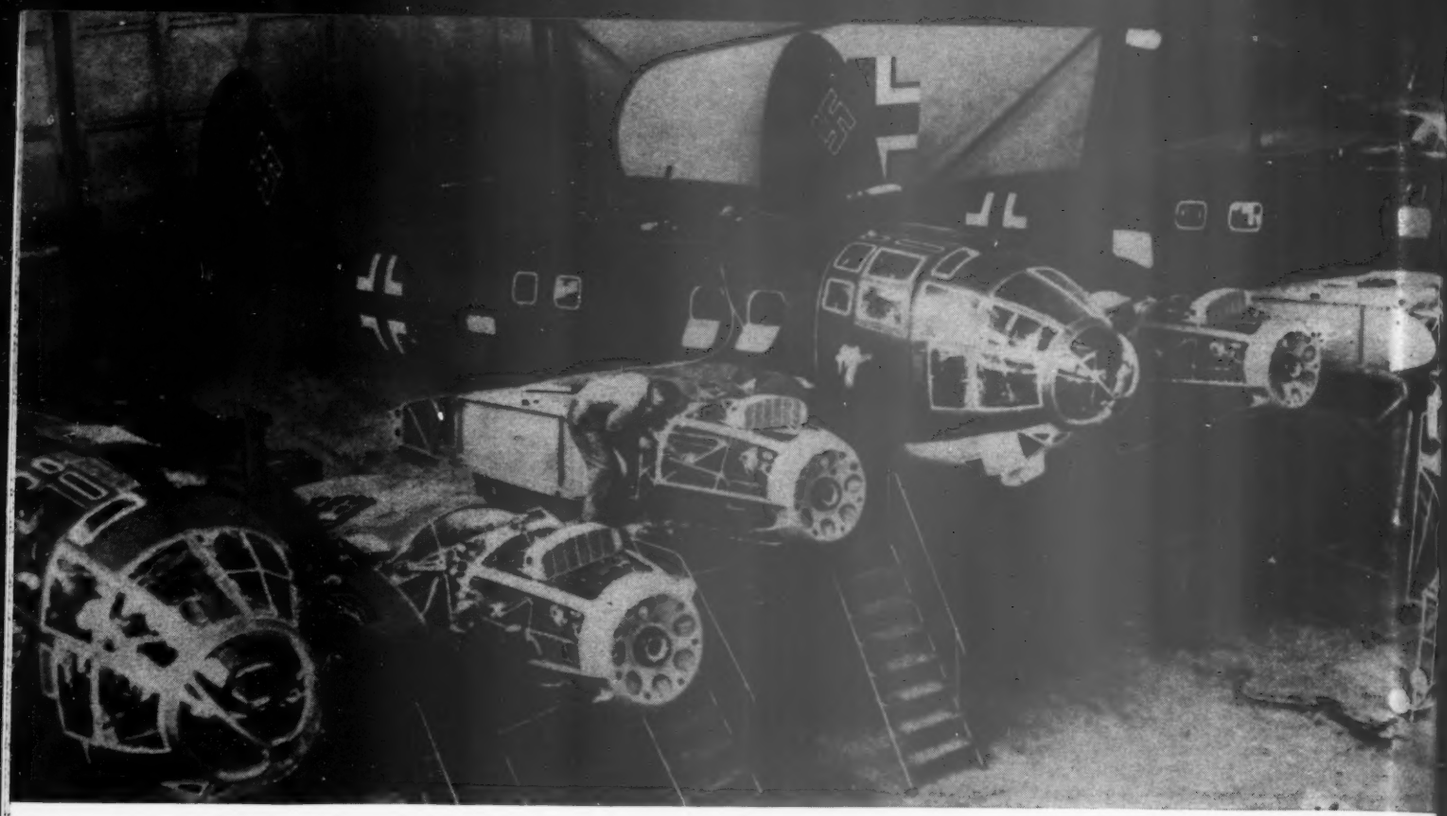
The success with which manufacturers of aircraft parts, as well as complete airplanes, have cooperated with other industries to speed the war effort is proved by Hamilton Standard Propellers division of United Aircraft Corporation. So well has Hamilton taught Nash-Kelvinator how to produce its propellers that a test of the vital interchangeability of parts made by both Hamilton and Nash-Kelvinator showed that any units, whether made by one concern or the other, fitted perfectly when assembled. In one instance, the dome assembly made by Nash-Kelvinator was fitted to the barrel assembly made by Hamilton—an operation which would have been impossible had there been a variance of but .00025 of an inch.

Such wholehearted cooperation by Hamilton, as well as by numberless other parts manufacturers, has increased production of aircraft accessories and, still more important, has built up behind the battle lines reservoirs of interchangeable spare parts.

(*Turn to page* 296)

The West Coast's Aircraft War Production Council's advisory committee on production, representing eight prominent southern California airplane manufacturers, at the Douglas plant. This group, like others within the industry, and individual companies, are cooperating fully with each other, licensees, subcontractors, government, armed services and others to exchange men, ideas, formulas and materials to speed the war effort.

Left to right: H. Virgil Gaudette, Lockheed; Harold Raynor, North American; E. Ezard, Consolidated; G. E. Barton, Ryan; H. D. Houghton, Douglas; H. Ryker, Vega; Harris MacIntosh, Vega; Jim Kelly, Consolidated; E. Malloy, Ryan; R. A. Lawson, Vultee; C. A. Sharpe, Vultee; F. Penn Holter, Lockheed; Ray Steinbauer, Douglas; Paul Buckner, Northrop; and R. R. Nolan, Northrop.



Factors Controlling Aircraft Design And Combat Performance

An authoritative analysis of American, British and German warplanes shows why record of United States craft is good and reveals fallacies in arguments of self-appointed critics of AAF planes—hitherto unrevealed glimpses of the future give sound reason for continued faith in our designers and builders.

By NATHANIEL F. SILSBEE
Major, U. S. Army Air Forces

THE AIRPLANE WAS NOT ALWAYS a military weapon. Orville Wright has more than once expressed his sorrow that the machine which he and his brother made a practical reality should have been used for such frightful purposes. Quite early in the history of heavier-than-air craft alert military men realized the latent potentialities of the airplane to bring new speed, new vision and new range to warfare.

As the airplane was applied to various uses in actual battle a few well defined types were developed. Models change with a breath-taking rapidity, but types remain fairly static. B-17E is a model, heavy bomber is a type.

Each desirable quality in airplane performance calls for a certain property, and the various properties conflict with each other to a remarkable degree. The aeronautical engineer's knowledge of his subject tells him what properties are necessary to produce the particular qualities he desires, and his skill or creative genius guides him in so adjusting the mixture as to obtain the most while sacrificing the least.

Thus it is practically impossible to get a high top speed without increasing the landing speed—sometimes beyond the safety point—particularly in combat

areas where large modern airfields are not available. This may produce what is popularly known as a "hot" ship, though it should be pointed out that the phrase really means a speedy high performance plane which, if mastered by the pilot, may prove to be actually safer to handle, both in the air and in landing. An example of the danger is the original German Heinkel He-113, a beautiful and cleanly designed fighter, but which landed so fast it proved a pilot-killer. It has since been redesigned, and has become a useful fighter, second only to the Messerschmitt Me-109F and Focke-Wulf FW-190.

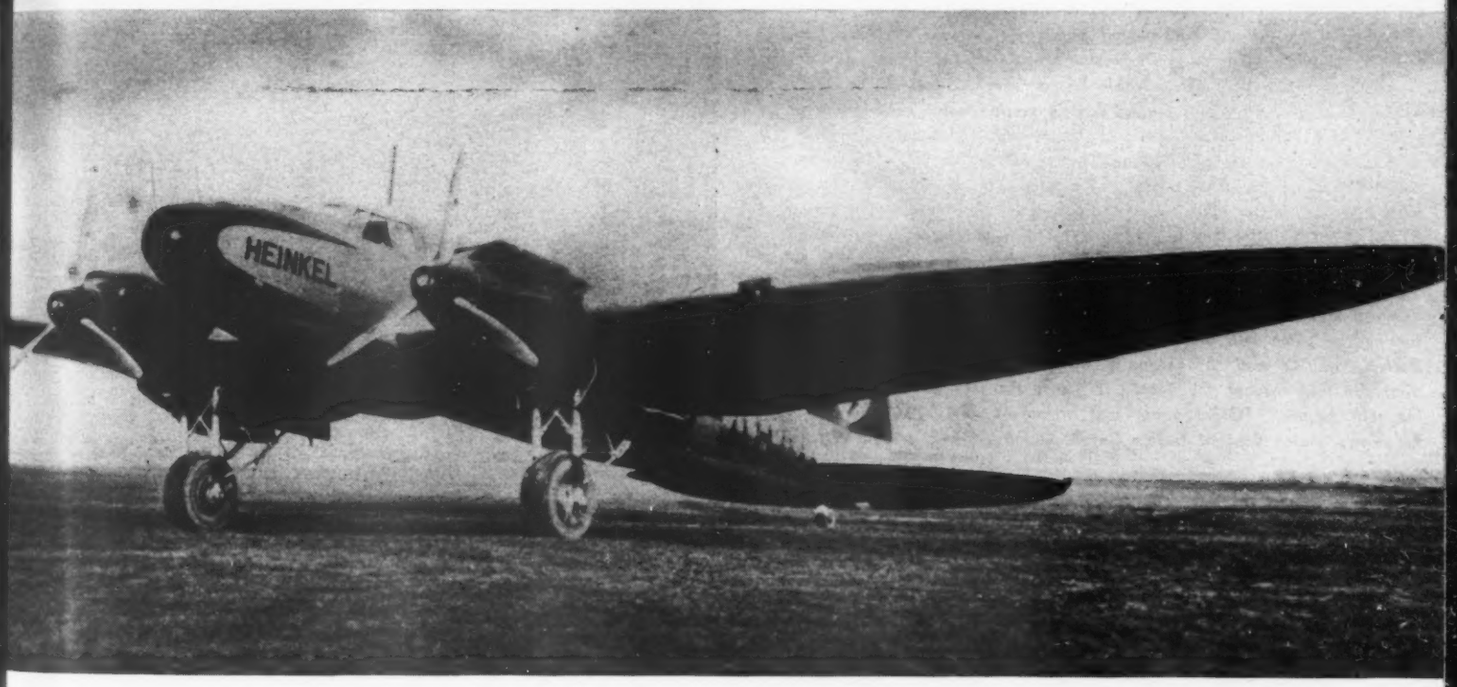
The best known current example of the fact that "you can't have your cake and eat it, too" in a military airplane is the Jap's Mitsubishi-00 Navy fighter, or *Zero*. To secure maneuverability, rapid climb and high ceiling not only were all pilot safety factors such as protective armor and self-sealing gas tanks sacrificed, but durability as well. Aluminum sheeting is very light, and the general construction far from rugged. Evidently both planes and the pilots are classed as "expendables," like bombs, guns, etc.

To gain the air superiority we need to win this war, America must have a sufficient quantity of high quality *airplanes*. We must have hundreds of thousands of well trained *airmen*—and and that means aircrews, as well as ground crews to "keep 'em flying." We must have *air bases* at strategic points, including landing fields, storage and maintenance facilities, housing and technical installations, and all that goes to enable a modern air force to carry on. We must have an *air supply* system to maintain American Air Forces offensive actions on the far-flung battle fronts. Our training programs, under the Flying Training Command and the Technical Training Command, have been expanding at an amazing rate, and well trained air and ground crews are coming out by the thousands every month. Our engineers and construction crews have been busy for well over a year establishing the necessary air bases for action in the main theaters of combat. In this paper we are concerned principally with the airplanes, but don't forget the other three elements in making up a balance and powerful striking air force. Some of the following points will appear elementary to many readers, but in estimating our progress in the race for air supremacy, and in order to properly evaluate much of the current discussions of our airplanes, it is important to get down to brass tacks.

In discussing airplanes it is important to remember that mere numbers, such as 50,000 or 100,000 per year, mean very little. The questions to ask are, "What exactly are these planes to be used for? What type do we need? How many of each?"

The basic functions of air power include: (1) Attack, (2) fighting, (3) observation, and (4) transport. Out of experience in the use to which airplanes are put certain general specifications have emerged. Military airplanes are designed to meet certain specifications as to exactly what that airplane is expected to do. Each model is a tailor-made job. It would be very convenient, and far less expensive, if a single type of airplane could be designed and produced which would perform all functions, but that simply is not in the cards.

It is true that certain of our aircraft have in actual use proved surprisingly versatile, and with minor modifications are performing three or four different chores better than anyone had a right to expect. The best example of this is the Douglas A-20 light bomber, used by the RAF as the *Boston III* for raids in occupied France and the Low Countries and by American units in the new role of dive bomber. It just about com-



Bomber development is illustrated by the Heinkel III, one of the most widely used types in the Luftwaffe. Its predecessor first appeared in 1935 as a "commercial" airliner (below) carrying twelve passengers. Soon a faster and more powerful version appeared, going in service in the Spanish Civil War. Engines have increased from 650 hp. to 1,150 hp. in the current He 111K-5; top speed has gone from around 200 to 275 mph.; and original armament of three 7.7 mm.-machine guns has been doubled and a 23-mm. cannon added.

pletes the circuit when we note that some of the newer models have been equipped to carry torpedoes. Here is versatility plus, but the reason is that specifications for this attack bomber type (as distinctively an American development as the long-range heavy bomber) are far less contradictory than for other more standardized types, in addition to which the exigencies of warfare have a way of prodding human ingenuity in no uncertain terms.

The main combat types are fighters and bombers, and the service types are observation planes, cargo and transport, and trainers, including primary, basic, advanced single-engine (for fighter pilot training), and advanced twin-engine (for training of bomber pilots, bombardiers, navigators, aerial gunners, etc.). For the most part we shall consider only the combat types. Each has definite design specifications to meet certain performance requirements.

Of the four functions of air power attack is fundamental, and air power should be regarded not as primarily concerned with airplanes fighting in the air, but as attacks on vital ground objectives *from* the air. That means bombers, backbone of any air force.

Primarily the bomber must be a good weight carrier, with sufficient range to reach distant targets and still get back, with allowance for adverse conditions. The yardstick for both heavy bombers and cargo planes is power-loading—the gross weight divided by the total horsepower, and the fewer the pounds per horsepower the better. A good average is between 12 and 13 lb.—the B-17E and C-47 are both about 12.5. From a design standpoint that means a large airplane with high lift wings, which limits maneuverability. To secure greater range, larger fuel capacity may be provided, but bomb load is thus reduced. This is one of the important differences between the British heavies, such as the *Stirling* and *Lancaster* and our long-range B-17's and B-24's. The former were designed to carry loads of six to eight tons to targets within 600 to 800 mi. at altitudes of 12,000 to 18,000 ft. American heavies were developed for high level daylight precision bombing at long range.

These characteristics are fundamental for a bomber, but hardly less important are the factors of speed so that enemy fighter planes will not be able to fly rings around it, and ability to carry its heavy load to high altitudes to escape the worst anti-aircraft fire which has been developed by practically all the belligerent nations, now effective up to approximately 25,000 ft. Superior horsepower and gear-driven or turbo-supercharging are the answers to these problems. From a military standpoint a correlative to high altitude performance is the precision bombsight.

An excellent example of the need of highly specialized design to meet specific performance requirements is the dive bomber. For more than 20 years dive bombing has been a specialty of our Navy and Marine Corps and, as is well known, the idea was seized by the Luftwaffe in the early thirties and developed in the Spanish Civil War. The Junkers Ju-87 *Stuka* (from *sturz kampf* or "diving fighter") was used with devastating effect in the Nazi campaigns of 1940. Meanwhile, the Army Air Forces continued development of *attack* aviation (now included in light bombardment), using fast, low-flying planes for ground strafing troops, ammunition dumps, machine gun emplacements, etc. The *Stukas* proved extremely vulnerable without local air superiority, as was proved not only in the battle of Britain, but in recent action in the desert, where Rommell lost Ju-87's by the score, with the RAF losing practically none of its Douglas *Bostons*. However, under certain conditions on land—and definitely at sea—the dive bomber may fill an important place as a specialized type.

Although there are still large numbers of the 5-year old Ju-87's in service, the real dive bombing threat of the Luftwaffe is the twin-engine Junkers Ju-88b, which came out in 1939. Also used as a level bomber for short-range bombing and long-range reconnaissance, this "all-purpose" bomber, with the Heinkel He-111K and the Dornier Do-217Z constitute the backbone of the Luftwaffe striking force, as four-engine heavy bomber types have not yet been extensively developed in Germany, the Focke-Wulf 200K *Kurier* and the Heinkel 177 being the principal models in this class.

Our Navy and Marines use the Douglas SBD *Dauntless*, and the Army Air

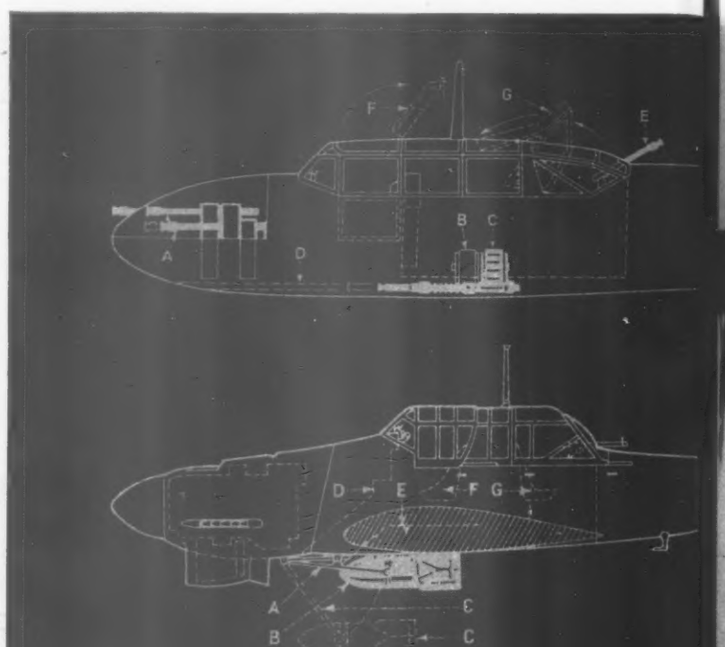


FIG. 1. (Top) No combat plane is better than its armament, and today eight .30-calibre machine guns are considered an absolute minimum. The Messerschmitt Me. 110 carries mixed armament. Located in the nose of the fuselage are four 7.9-mm. machine guns in staggered position at "A." Also firing forward from a fixed position are two 20-mm. cannon "B" and "C" set below and behind pilot's seat. Note the long flash tube "D" through which the shells pass before leaving the plane. Remaining armament consists of one movable 7.9-mm. machine gun "E" operated by the rear gunner. "F" is hinged canopy section which swings back to provide pilot's escape hatch, and "G" is movable canopy over the gunner's cockpit. (For other details on German aircraft armament see page 200.) FIG. 2. (Below) Dive bombing was originated in this country more than 20 years ago, but the Germans did a good development job during the Spanish Civil War. The famed Junkers 87b, details of which are shown here, is extremely vulnerable without local air superiority. In normal flight the bombrack "A" is retracted to hold the bomb "B" flush against the fuselage. As the pilot approaches the target the rack is extended, moving the bomb into the position indicated by the dotted lines "C." Dotted lines "D" and "E" outline a transparent panel through which the pilot can look through the floor. "F" is pilot's seat and "G" that for the rear gunner. (Other armor and armament details were given in Aviation's Sketch Book of Design Detail, October, 1942, page 154.)

Forces have a similar version known as the A-24. The Vultee A-31 *Vengeance* is a newer model, built for the British. The Army equivalent of the Curtiss SB2-C, Navy's *Helldiver II*, is the A-25 which is expected to be the most powerful dive bomber in any service. A dive bomber version of the North American P-51 *Mustang* is now in production for the Army Air Forces.

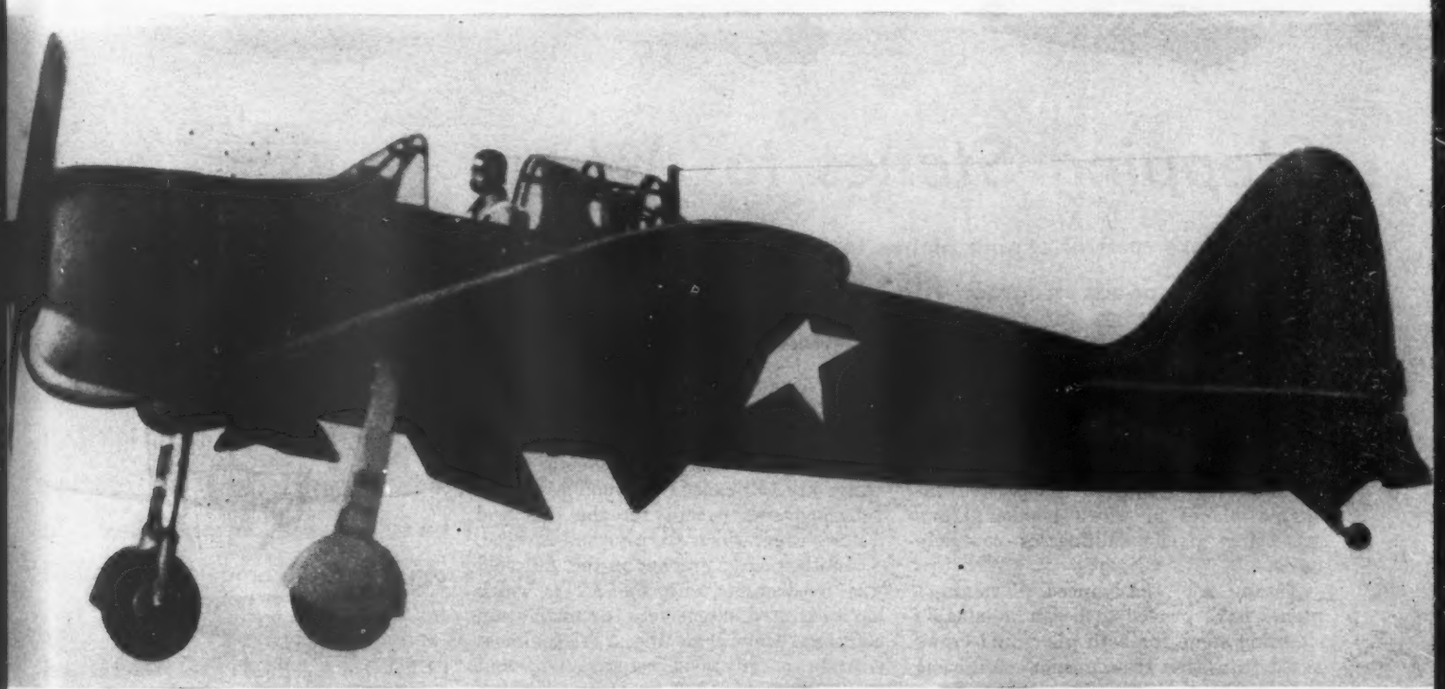
Air fighting, hardly less important than air attack, has two main purposes: First, defensive—the interception of hostile bombers—and second, offensive—gaining air superiority during an attack. For this two-fold purpose modern fighter planes have been developed by different countries which, on the whole, have proved to have similar characteristics and performance.

An excellent illustration of this is found on the engine data card found in the cockpit of a German Focke-Wulf FW-190A3 shot down by the RAF. Its rate of climb showed "3,050 ft. per min. at 4,000 ft. with supercharger in M gear, and 3,280 ft. per min. at 17,500 ft. supercharger in S gear."

Compared with the 2- or 3-ratio gear-driven supercharger the turbine-driven supercharger is more flexible and provides a greater range of altitude at which maximum power can be obtained. The design compromise on the matter of high speeds at all altitudes has not yet gone beyond the stage of practically two types of fighter planes for our Army Air Forces, those of critical altitudes work. The Hawker *Typhoon*, with Napier *Sabre* 2,200-hp. engine is reported in production, and from all indications will be faster and more effective at high altitude.

The Germans have three first-line fighters, all with fairly high ceiling. Fastest is the Heinkel He-113, powered by a Daimler-Benz 603 inverted V-engine of 1,300 hp., but the other two, the Focke-Wulf FW-190, and especially the Messerschmitt Me 109F, are more effective at high altitudes.

Second only in importance to speed in relation to altitude is climb. Enemy bombers approaching at 20,000 ft. at 300 mph., penetrate 5 mi. every minute. If the fighter planes require 6 or 7 min.



Fighter plane design is always a compromise, as is illustrated by this first picture of a Jap Zero captured almost intact in the Aleutians. Its high rate of climb, good maneuverability and high ceiling have meant sacrificing all protective armor, holds fire power down and necessitates light construction which presents difficult maintenance problems. Being test-flown by American pilots, it carries United States markings.

Design Problems

The conflicting requirements for a single-seat fighter plane constitute an aeronautical engineer's nightmare. First of all is speed, speed sufficient to exceed that of enemy bombers and fighters at any and all altitudes. This problem of superior speed at any altitude is one of the most difficult of all. Owing to the fact that engine power falls off as the airplane goes higher and higher, every military plane has a critical altitude at which it performs best, depending on the supercharger.

about 13,000 ft. with a service ceiling up to 25,000, and the distinctively high altitude jobs which operate effectively up to 38,000 or 40,000 ft. with turbo-superchargers. (We don't know yet if these or any other planes can *fight* effectively up that high).

In the first class we have the Curtiss P-40 series, the Bell P-39 *Airacobra* and the North American P-51 *Mustang*. In the high altitude class we have the Lockheed P-38 *Lightning* with two Allison supercharged engines, and the Republic P-47 *Thunderbolt*, powered by a 2,000-hp. *Double Wasp*. The British use the *Hurricane* for low and medium levels, and the newest *Spitfire* for high altitude to reach that altitude, the bombers will have progressed between 30 and 35 mi. during that time. A high rate of climb insures ability to intercept the enemy more quickly, a feature very prominent in German design. It is also of interest to note that the Jap Navy *Zero* has this as its leading characteristic.

The conflict of design features between high speed and fast climb resolves itself to this: speed requires high power and low drag, small wing area and highly streamlined contour. Climb demands high power and large wing area compared with total weight. Net result, as usual, a compromise.

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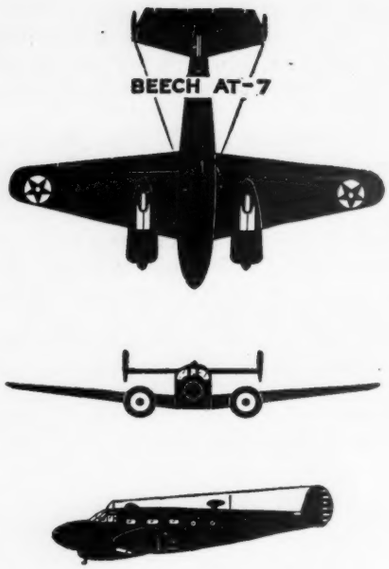
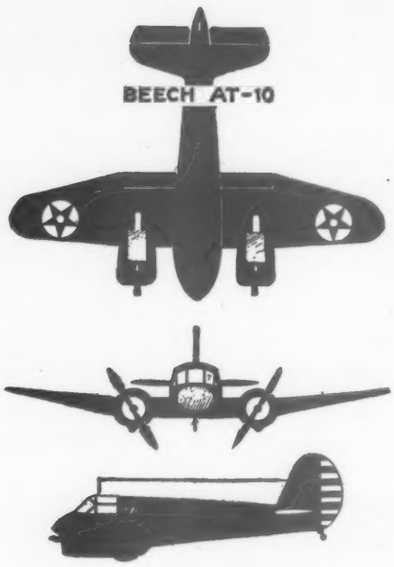
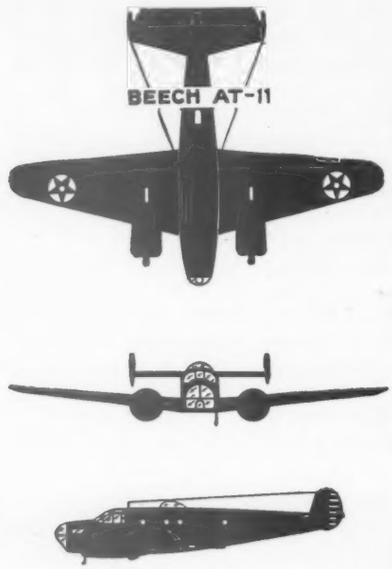






Stepping Stones to Action

Growing use of twin engine planes to train bomber crews as complete team speeds program with increased efficiency and means additional types to add to spotters' recognition lists.

FLYING through practically all daylight and night hours in many parts of the United States and Canada are growing numbers of four- to six-place twin-engine planes in which bomber crews are being given training as complete units.

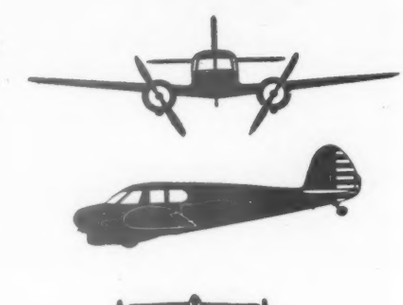
These AT (Advanced Training) planes have proved to be an invaluable stepping stone for both pilots and crews in the transition from primary and basic training up to the big twin- and four-engine long range bombers, they will use in actual combat. Too, they have meant a great saving in operational equipment, since bomber crews formerly had to train on either obsolete types or tie up sorely needed first line planes.

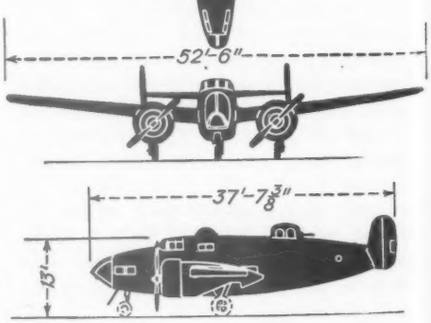
One of the first to go into service was that built by Cessna Aircraft Co. About the time hostilities broke out abroad, Cessna had just completed tests on a new twin-engine five-place cabin plane designed primarily for private use. Quickly adaptable for military use, it was ordered almost immediately by the Royal Canadian Air Force, where it is designated the *Crane*. Expansion of our own air forces brought orders for still more, the first of which were designated AT-8; later models, very similar in appearance, are designated AT-17, or the *Bobcat*.

The AT-8, shown here, has a wing span of 41 ft. 11 in., a length of 32 ft. 9 in., and height of 9 ft. 11 in., and is powered by two Jacobs L4MB radial engines. The fuselage is welded steel tube, fabric- and dural-covered; the wings are full cantilever wood structure, fabric-covered except for the tips and leading edge, which are plywood-covered.

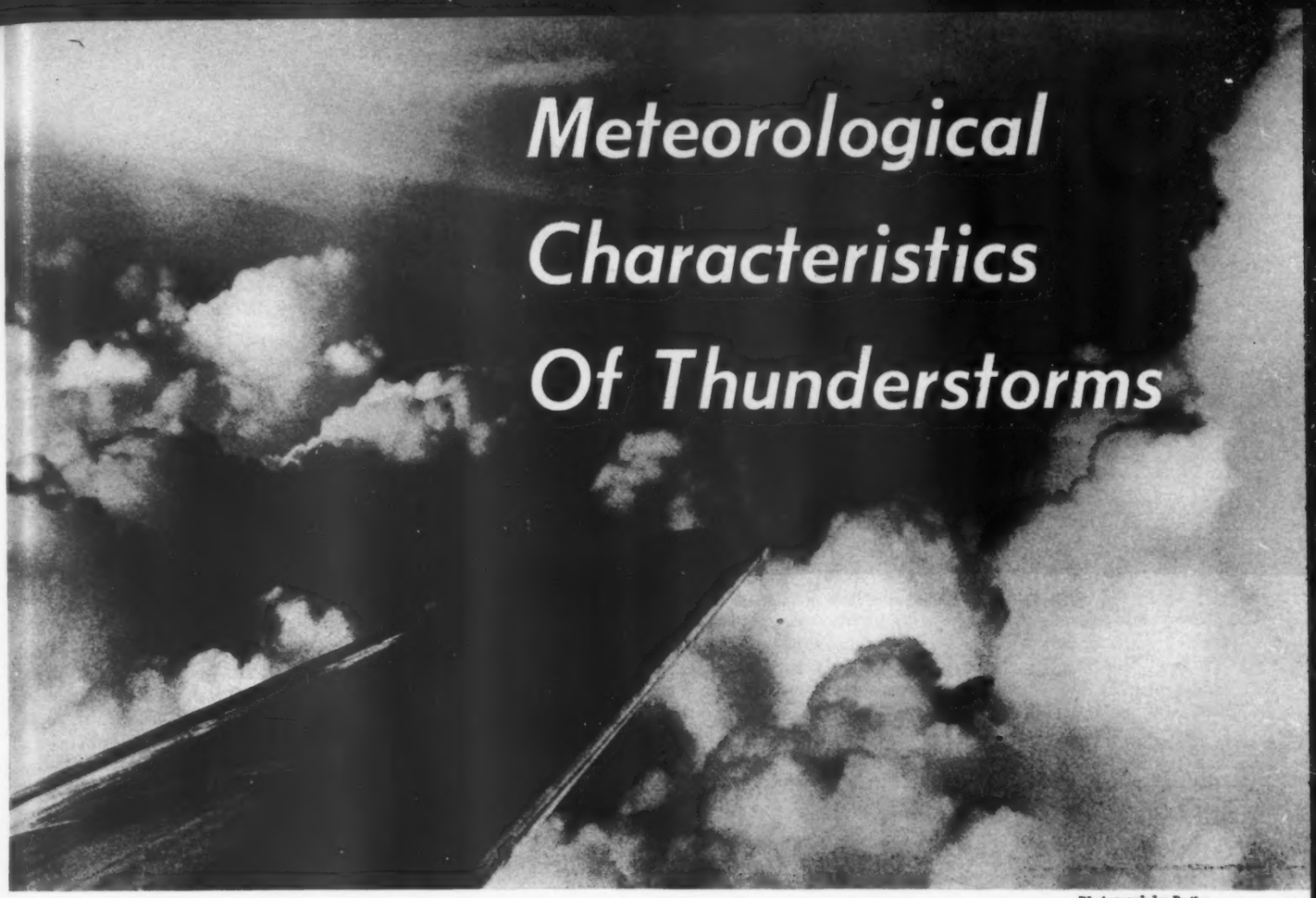
Another early entrant in the AT field was Beechcraft, with the AT-7, which has been used extensively for navigation training. Then came the AT-10, almost entirely of plywood construction, and powered by two 280 hp. Lycoming engines. Note that, unlike the other Beechcrafts, it has a single rudder. This was followed by the AT-11, a low-wing all-metal craft used for specialized training of bombardiers and gunners. It is equipped with flexible guns and bomb racks for instructing a crew of three or four men, depending upon the instructional mission. The AT-11 has a wing span of approximately 47 ft., and length of 35 ft. It is powered by two 450 hp. Pratt & Whitney engines.

Latest of the crew trainers is the Fairchild AT-13, the first of this category to use tricycle landing gear similar to that found on operational planes. It was described on page 225 of AVIATION, August, 1942. Built almost entirely of plywood by the Duramold process, it has a wing span of 52 ft. 6 in., length of 37 ft. 7⅜ in., and height of 13 ft. (See AVIATION, *October, 1942*, p. 203 for "Final Training for the Real Thing.")





Meteorological Characteristics Of Thunderstorms



Photograph by Butler

PART II. Last month the duration, movement relative to gradient to winds, and circulation pattern of thunderstorms were discussed. In this concluding article, the energy characteristics of thunderstorms are analyzed including the storm accumulative factors and energy expended. In addition, some helpful suggestions to pilots are given.

By GEORGE N. BRANCATO,
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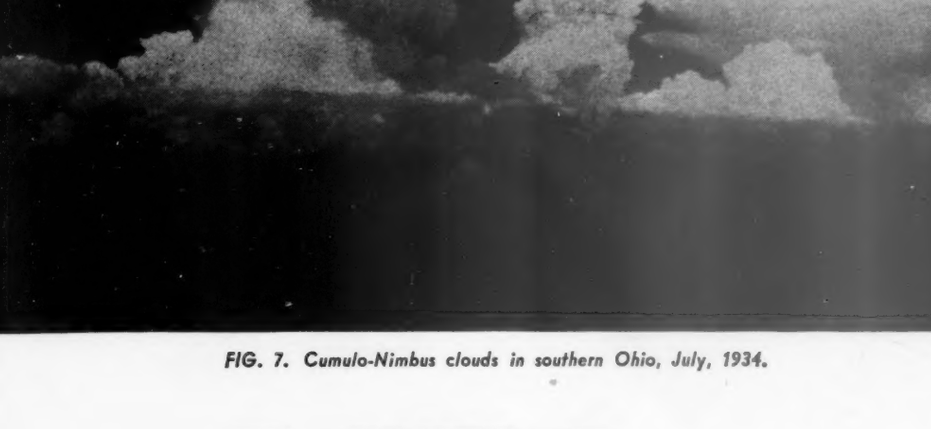
THE VIOLENT AND OFTEN destructive squall winds during the early period of thunderstorm as well as the excessive vertical velocities, frequently exceeding 100 mph., in the center of the storm cloud are a source of concern not only to the airlines, who often have to fly through them, but to the public in general. One of the best discussions and explanations of these violent winds is given by Humphreys[2]. By making use of the dense network of stations in the Muskingum Watershed and the daily soundings taken at nearby Wright Field, Dayton, Ohio, it has been possible to substantiate his explanation of these winds and make some additional suggestions. Humphreys explains that "The passage of a cumulus cloud overhead, however large, so long as no rain is falling from it, does not greatly affect the direction and magnitude of the surface wind and does not bring on any of the familiar gusts and other thunderstorm phenomena. Hence, somehow or other, the rain is an important factor, both in starting and in maintaining the winds in question, for they do not exist before the rain begins or continue after it has ceased. On the other hand, it cannot be assumed that the rain is the whole cause of these winds, for they do not accompany other, and ordinary showers, however heavy the downpour may be."

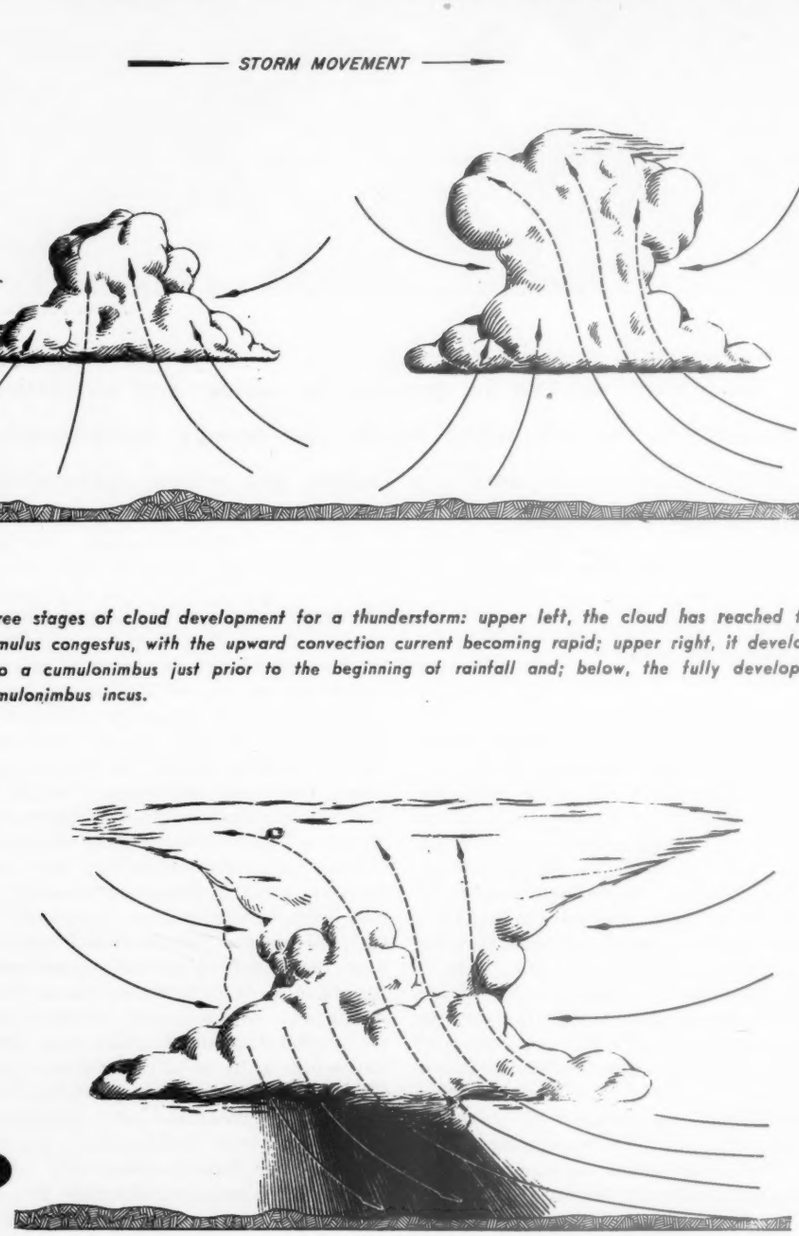
On Fig. 4, are shown three stages of cloud development for a thunderstorm. The first stage shows the streamlines of uprising air due to the establishment of an approximately adiabatic lapse rate to the base of the cloud. The cloud has reached the cumulus congestus stage and the upward convection current is becoming rapid but the compensating downward current is relatively widespread and gentle. In the second stage the cloud is developing into a cumulonimbus just prior to the beginning of rainfall. Here the upward vertical velocity due to convection and the release of latent energy has increased greatly but since the compensating downward current is relatively widespread as compared to the concentrated core of rising air, the downward current is still correspondingly gentle. The third stage is the fully developed cumulonimbus incus and shows the streamlines which have now developed as a result of falling rain. There is both a vigorous ascending and descending current, the latter frequently being in excess of 60 mph. at the ground level and the former occasionally being sufficient to sustain hailstones two or more inches in diameter.

Photograph by Butler

FIG. 7. Cumulo-Nimbus clouds in southern Ohio, July, 1934.



Three stages of cloud development for a thunderstorm: upper left, the cloud has reached the cumulus congestus, with the upward convection current becoming rapid; upper right, it develops into a cumulonimbus just prior to the beginning of rainfall and; below, the fully developed cumulonimbus incus.



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A brief summary of Humphreys' explanation for these streamlines and velocities follows: The air mass in which a thunderstorm develops is usually conditionally and convectively unstable. The moisture distribution under these conditions is such that there is a decrease in wet bulb potential temperature with elevation and the air which produces the cumulonimbus cloud comes from essentially the lower kilometer or so of the atmosphere. After a time, as a result of the abundant condensation induced by the convectional cooling, cold rain or rain and hail from above the zero isotherm level, begin to fall, and as long as it falls it cools the air through which it is falling by contact and evaporational cooling. By setting up some reasonable assumptions relative to (1) the height of the column of air through which the rain falls, (2) moisture content of the air, and (3) the temperature change with elevation, he has shown that the amount of cooling due to evaporation as compared to conduction is of the order of 6 C. to 0.5 C. The result of this evaporational cooling is a distinct increase in density of the air which then establishes the characteristic local down-rush of cold air. The lowest temperature of this air is determined by the lowest wet bulb temperature of the column of air through which the rain is falling.

Temperature Differentials

A test of the validity of this reasoning would be to obtain the lowest wet bulb temperatures from upper air soundings for a series of thunderstorm situations and compare these temperatures with the observed minimum temperatures produced by the thunderstorms. The temperature and wet bulb curve for an actual sounding have been plotted on Fig. 5, showing the air which rises and forms the cloud, and the air

which descends due to cooling by evaporation producing the low surface temperatures. Since evaporation into this air is continuous all the way to the surface, its temperature at the surface would be obtained by following the wet bulb potential temperature curve to the surface pressure. In some cases it was found that the minimum wet bulb temperature would be only a point on the curve and would not be representative of the volume of air comprising this violent outward current. In order to standardize the method the minimum average wet bulb temperature through a column about one kilometer thick was used.

The hourly temperature readings taken by the dense network of stations in the Muskingum Watershed were used to obtain the minimum observed temperatures, thus making certain that temperatures near the center, and most representative of the downrushing air, were used. Also the cases were limited to those in which the cooling could not be ascribed to a frontal passage. Each case used was carefully studied in order to be sure that the sounding was representative of the air which produced the thunderstorms. Most cases selected were those for which representative soundings at Wright Field, Dayton, Ohio, were available. It was possible to investigate 26 thunderstorm situations in this manner and a comparison of the observed minimum temperatures with the derived temperatures is shown on Fig. 6. In four cases the difference was 3 F. and in the remainder it was 2 F. or less. This is remarkable agreement considering (1) the inaccuracy of humidity measurements in soundings, (2) the fact that the temperatures obtained were actually the minimum temperatures obtained from the hourly readings made over the Muskingum area and not the actual minimum which could have occurred between hours, and (3) the standard procedure which it was necessary to adopt relative to the wet bulb temperature used. In practically every case where the observed temperatures were lower than the derived temperatures closer agreement could have been obtained by using a value of the wet bulb temperature nearer the extreme minimum indicated by the sounding.

Energy Transformation

In his discussion of energy transformation in a closed system Margules[3] has shown that in the rearrangement of two air masses of different temperatures lying side by side the resulting wind velocity is given by the simple equation:

$$\overline{C} = \tfrac{1}{2}\sqrt{gh\,\frac{\Delta T}{T_m}} \qquad (t, \text{deg. abs.})$$

where g=gravity, h=height, ΔT=the difference between the mean temperatures of the air masses and T_m= the mean temperature of the two air masses.

In a thunderstorm we can assume analogous conditions between the moist air lifted by convection and the descending air cooled by evaporation.

Using data from an actual sounding, Fig. 5, which are typical for convectively unstable air it is possible to calculate the wind velocity which would result from evaporational cooling of the air. The lowest wet bulb potential temperature, 291, through a thickness of about 1 km. has been drawn on the chart and since evaporation of rainfall into this air would continue to the ground the temperature in this column of air would follow the pseudo-adiabatic curve. By using an average specific humidity value of 15.0 g. for the lower kilometer of air and adiabatic conditions to the condensation level, the temperature of the rising column of air above the condensation level can be identified by the 297 wet bulb potential temperature curve.

We can use $\Delta T = 8C$ as representative of columns 4,000 m. high (h), in which case $T_m = 283$, and

$$\overline{C} = \tfrac{1}{2}\sqrt{9.8 \times 4{,}000 \times \frac{8}{283}}$$

$$= 16.7 \text{ m/sec. or } 37.4 \text{ mph.}$$

Add to this the speed of the thunderstorm relative to the earth's surface which can be assumed to average 15 mph., then the velocity of the squall winds experienced at the surface would be about 52 mph. This velocity is not at all unusual in a severe thunderstorm.

The amount of temperature drop experienced by pilots flying through thunderstorms has been mentioned by H. T. Harrison of United Airlines in a paper on Pre-Frontal Squall Lines. From a study of a series of pilots' reports he reached the following conclusions. "No sustained temperature change is reported through the squall line aloft. The typical report of a plane passing through the line from east to west consisted of an abrupt fall in temperature of 8 to 15 F. as the region of rainfall was entered, then followed by a rise to approximately the original level after passing out into the clear zone beyond. The greatest temperature fall (momentary) appeared to be in the lower levels from approximately 6,000 to 2,000 ft. m.s.l." This verifies the average difference in the temperature of the ascending and descending currents.

Maximum Intensity and Dissipation

The temperature differences established by evaporation from falling rain suggest that a considerable amount of energy can be supplied to a growing thunderstorm in a relatively short period of time after rain has begun to fall. This can account for the fact that a thunderstorm usually acquires its maximum intensity within an hour or so after it reaches the rain stage. The rapidity with which the great amount of energy is supplied may also explain the short duration of a single thunderstorm which is usually less than three hours. As the column of cold air flows down, it rushes forward in the direction of the storm movement, acting as a shallow surface front. The speed of this air usually is greater than the speed of the storm so that within a short time it has underrun and buoyed up the warm moist air well in advance of the storm and has served as the initiating impulse to develop cumulus congestus clouds into cumulonimbus. This then cuts off the inflow of moist air into the parent thunderstorm which slowly dissipates but in the meantime the lifting effects of the outflowing cold air also account for the development of families of thunderstorms which was one of the

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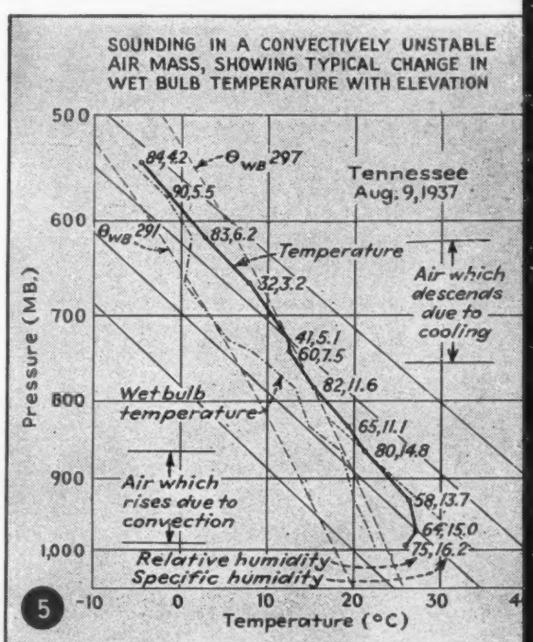

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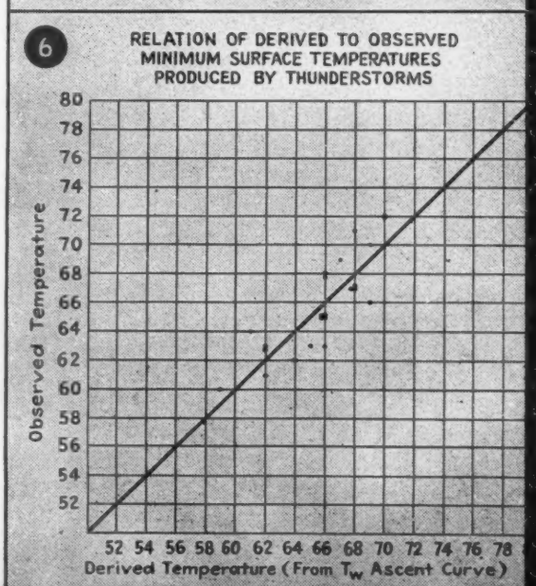

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Extensive tests conducted at Douglas Aircraft Co. plants over many years prove that careful supervision of worker nourishment and eating habits pays big dividends in better production and morale.

Proper Feeding Boosts Worker Production

By LUCIUS S. FLINT

BACK IN 1937, two welders at the Santa Monica plant of the Douglas Aircraft Co.—their names were Stevenson and Thompson—decided to "go into business." They hadn't much capital for the venture—only a $10 bill between them—but they were possessed of ideas. Here were hundreds of men doing precision work on airplanes. Their jobs took a lot of energy. And sometimes the old energy supply seemed to run down between meals.

What the men needed was more food, the two welders reasoned—quick energy food that could be eaten right on the job without loss of time. So, they invested that tenner in several boxes of candy bars and set up shop in a bench drawer.

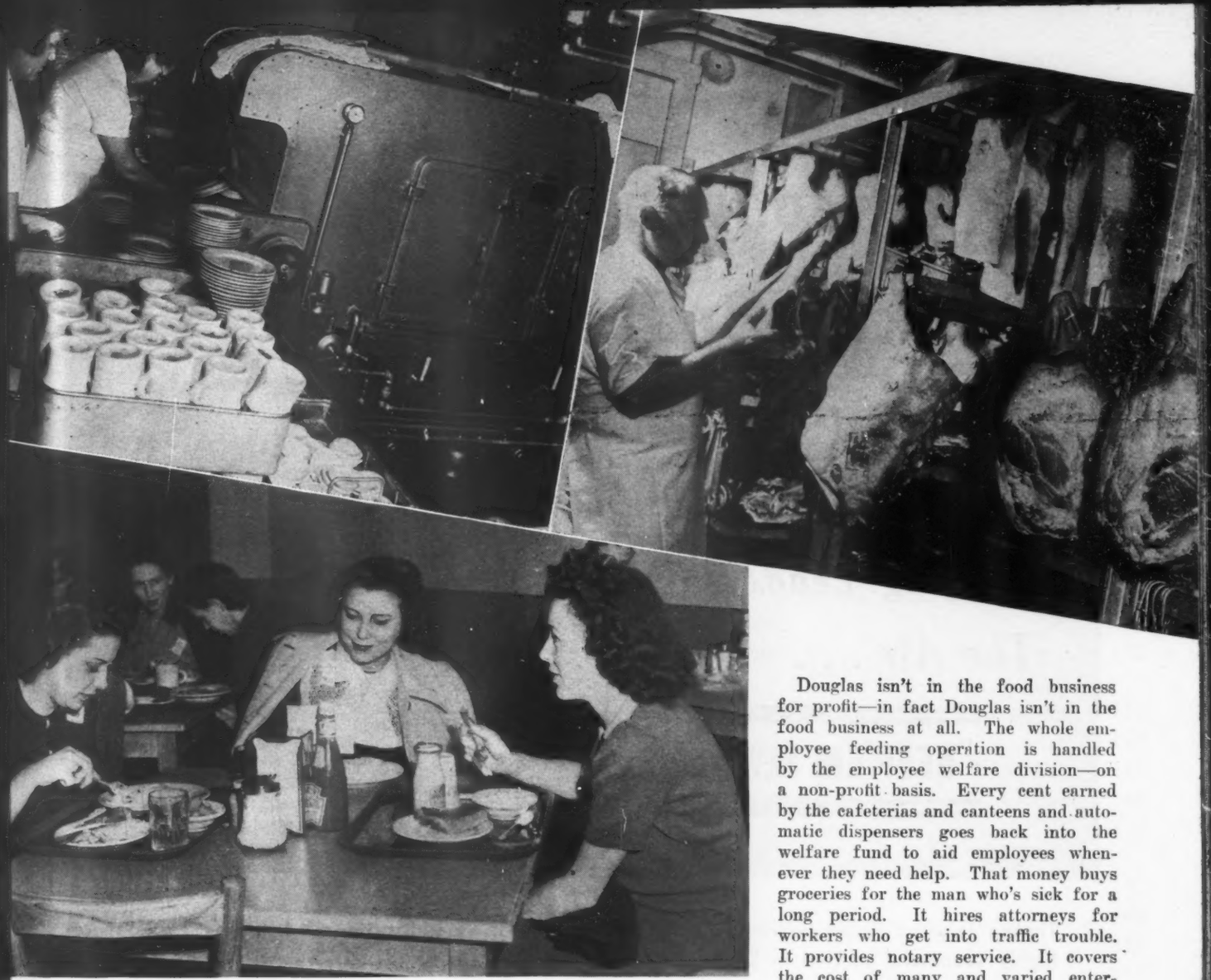
Stevenson and Thompson dropped a word to the boys at the next bench—"If you're fagged, come over and get a candy bar." The news spread. That first day the "partners" sold out and reinvested their earnings in some more candy. In a few weeks they were doing so much business that the drawer wouldn't hold a day's supply of candy.

And the surprising thing was that production began jumping almost in direct proportion to the amount of candy consumed. The foreman noticed it, reported to his superiors. Word got around to President Donald Douglas who, being a farsighted man with progressive ideas, came down to investigate.

A few days later, with due official blessings, the erstwhile welders had a portable cart and were peddling candy all over the plant. Soon they added soft drinks—and then ice cream bars and then sandwiches. And, the more they sold, the more work the plane-makers seemed to do.

Thus began the present mass-feeding operations of the Douglas Aircraft Co. And thus was introduced a new theory in the handling of men—the theory that ability of a man to produce depends very definitely on what he eats and how much of it.

As a result of the early Santa Monica experience, Douglas officials became very much "food-minded." They encouraged Stevenson and Thompson to expand their service, aided them in establishing permanent canteens. Later



TOP AT LEFT: Modern equipment, such as this automatic dishwasher, expedites prompt feeding of thousands of aircraft workers and maintains highest sanitary standards.

TOP AT RIGHT: Douglas was probably the first plane manufacturer to encourage the serving of healthful, nourishing breakfasts to workers. Such breakfasts, served morning, noon and night, include eggs, chops, steaks and potatoes.

ABOVE: Recognizing that good food alone is not enough, Douglas provides pleasant, comfortably furnished cafeterias at convenient locations. In addition, portable canteens serve out-of-the-way sections of plants and make rounds between meals.

LEFT: Employee feeding is treated as an exact science at Douglas plants. By appetizing and colorful displays of food, most workers are tempted to select well-balanced meals, including vegetables and fruits.

on the company's stamp of approval was placed on the opening of the first aircraft cafeteria in the nation—the one at the Santa Monica plant.

Today, Douglas has anywhere from one to a dozen or more cafeterias in each of its plants—to say nothing of soda fountains and hundreds of soft drink and candy bar machines. And, the management traces no small share of its production record to the food dispensed in those outlets.

"Careful tests have convinced us beyond any reasonable doubt that the man who eats three good hot meals a day and who has access to flash energy between times if he needs it—in the form of candy and soft drinks—is a better producer," says Donald Douglas. "Good food, hot food, increases the general standard of health; it means fewer 'sick days'; it means fewer accidents; it means less material spoiled; it means more work of better quality.

Douglas isn't in the food business for profit—in fact Douglas isn't in the food business at all. The whole employee feeding operation is handled by the employee welfare division—on a non-profit basis. Every cent earned by the cafeterias and canteens and automatic dispensers goes back into the welfare fund to aid employees whenever they need help. That money buys groceries for the man who's sick for a long period. It hires attorneys for workers who get into traffic trouble. It provides notary service. It covers the cost of many and varied entertainments. It helps the worker in just about every way he could desire.

And, still the employee gets a real value in food. For 35c. he can buy a meal that will satisfy the huskiest appetite—a meal that in a commercially operated restaurant would probably cost from 60c. upward.

The answer here, of course, lies in volume buying and in modern, mechanized kitchen equipment which eliminates all unnecessary labor in food preparation and service. All staple buying for the various cafeterias is done through central headquarters—whole beeves by the score, carloads of the finest, nationally-known ham and bacon and so on.

Huge bakery kitchens in all the plants provide fresh bread and rolls and cakes and pies and pastries of the finest possible quality at a cost far below the commercial price. Big, automatic vegetable peelers prepare enough potatoes for thousands of men in a matter of minutes. Automatic dishwashing equipment washes and dries everything

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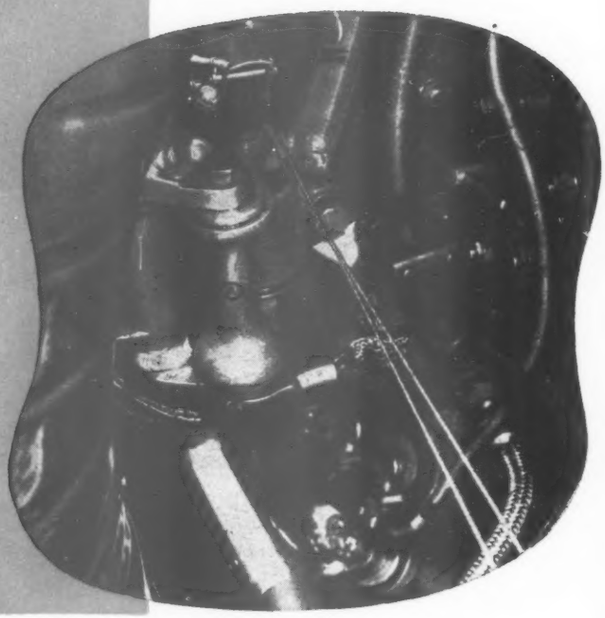
Horsepower literally floats on Timken Bearings

Dynafocal Suspension Service Reaffirms Timken Bearing Leadership In The Air . . .

"KEEP'EM FLYING!"



Timken Tapered Roller Bearings have given highly successful service in Dynafocal suspension assemblies.

The bearings are used in links spaced symmetrically around the engine mounting ring and connected to the rear of the engine. Each link has two pivot points; one a tube and the other is formed by two Timken Bearings pressed into the link forging. Through controlled directional spring restraint, this flexible mounting arrangement results in a true center of gravity support for the assembly, the isolation of vibration and yet contains sufficient stability for landing and erratic flying.

Timken Bearings permit the links to float freely. They must carry radial loads set up by the thrust of the propeller plus weight of the engine and thrust loads resulting from propeller torque. Here is still another instance of the "know how" possessed by The Timken Roller Bearing Company in applying bearings in unusual applications, particularly aircraft.

★

As aircraft speeds and loads increase the advantages of Timken Bearings become more pronounced. In new designs study bearing applications with this thought in mind.

THE TIMKEN ROLLER BEARING COMPANY, CANTON, OHIO

Manufacturers of Timken Tapered Roller Bearings for automobiles, motor trucks, railroad cars and locomotives and all kinds of industrial machinery; Timken Alloy Steels and Carbon and Alloy Seamless Tubing; and Timken Rock Bits.

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TAPERED ROLLER BEARINGS

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PRODUCTION • DESIGN • RESEARCH • ENGINEERING

Wood Techniques Developed in Glider Construction 108
Developing Graphic Illustrators ..... R. R. Weise 113
Design Considerations for Plywood Structures ... L. J. Marhoefer 114
Range of Drop Hammer Operations
Chris J. Frey and Stanley S. Kogut 118
The Future of Water-Based Airplanes, Part VI
Capt. Frank T. Courtney 122
SAE Holds Aircraft Production Meeting 124
Tool Design Gains Importance ..... John J. Scheppe 129
Fabricating Plastic Dies for Acrylate Sheets ..... Kenton S. Leeg 143
Planes From Paper 138
Heliarc Welding Opens New Horizons in Aircraft Design and Construction 147
Flight Recorder to Ease Test Pilots' Job 149
Shortcuts Speed Propeller Production 151
Plastic Engine Parts Save Aluminum 153
Coaxial Electric Propeller Developed by Curtiss-Wright 153
Review of Patents ..... A. Harry Crowell 153
Factory Maintenance Section
Maintaining Arc Welders for Peak Production ..... R. F. Wyer 133
AVIATION's Sketch Book of Design Detail
Retracting nose wheel of the Douglas C-54 cargo plane 154
Air brake fitted to Dornier 217 for dive bombing 154
Bomb racks of the British "Manchester" heavy bomber 157
Elevator control torque tube of the Vought-Sikorsky VS-44A .. 157
Retracting landing gear mechanism of the Focke-Wulf 190 157
Aft fuselage structure of the Douglas A-20 158
Tail wheel installation of North American trainer 158
AVIATION's Engineering Data Book
Power Presses: Tonnage Capacities on Presses 161
Die Cushion Size and Ring Holding Pressure Required 163
New Products and Equipment for the Aviation Industry
Information Tips on Timely Aviation Topics 164
Modern Machine Tools 165
Shop Equipment and Accessories 168
Subcontractors Section
Subcontracting Practices at United Aircraft 189
Men and Machinery Available for War Work 191

Wood Techniques

Developed In Glider Construction

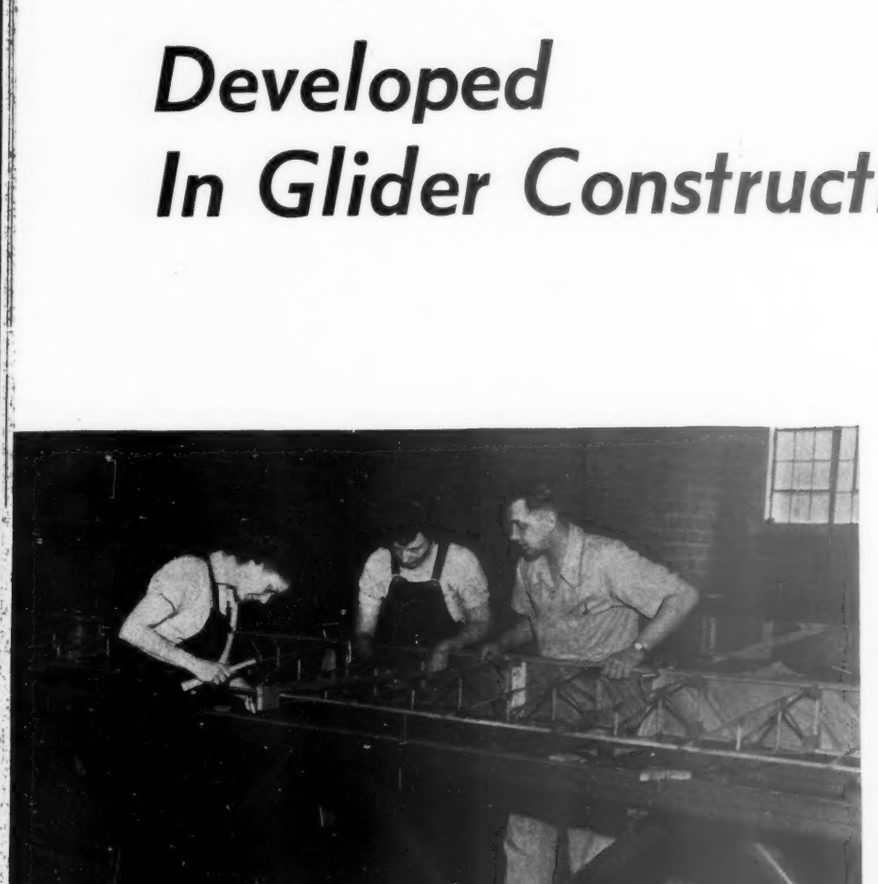


Fig. 1. Massive fixtures of welded steel securely locate wing while closing skin is glued on and metal fittings applied. Thin steel nails spaced 1-in. apart are used to tack skin to each rib and along each edge. The problem of applying and removing them quickly was solved ingeniously. Nails are driven by girls into 1x¼-in. poplar strips. Over each glued joint is placed a strip of 1-in. canvas belting, then the poplar tack strip. Nails are driven through strip, belt and skin into rib. After the glue is dry, nails are quickly pulled out by yanking upward on the cotton belting. The first skin in the illustration has just been tacked in place this way.

FIG. 2. Inserting the trailing edge of the wing is a delicate operation done by girls. It is glued and nailed to the tips of the ribs between which it is inserted. This edge must be straight, the correct distance from the rear wing spar and the ribs at right angles. The girl doing the tacking has a dolly beneath the work, the other girl is pulling the trailing edge into place at exactly the right distance from the spar. Rigid steel tubular fixture brackets keep ribs in exact alignment and at proper height while glue is drying.

"Furniture City" craftsmen working toward large-scale production of transport gliders. Wooden fixtures and hot-press drying are features of wood construction technique.

FIFTEEN YEARS AGO, aluminum and steel began to replace wood for airframes; the present skilled aircraftsman is a metal, not a woodworker.

But the shortage of steel and aluminum has changed this picture. One of the most important Army Air Forces programs today is to provide transport gliders without robbing the rest of the aircraft industry of critical metals. Laminated-wood construction was the logical and entirely practicable way to do it. The important problem was to find a source of supply—a community where there was available factory space, suitable tool equipment and experienced wood craftsmen. What could have been more logical than to turn to the furniture industry—to the "Furniture City" —Grand Rapids?

A large aircraft producer got the order for building these new plywood transport gliders. The next step was to find manufacturing facilities to turn them out fast enough to meet Army Air Force requirements. The quick action required on this job could never have been obtained without the wholehearted cooperation between two unrelated industries. As a business problem it required a responsible allied contractor, Grand Rapids Industries, Inc., supplied that link.

The accompanying photographs and captions explain how accurately the parts are held to dimension in special jigs and fixtures, also some of the special equipment that was developed. Few industries were better equipped for a job; plants are able to use almost 100 percent of their woodworking tools. In a few cases, new tools were added because of the size of parts to be finished. The spar shaper of Fig. 7 is an example. Hot-press drying of glued parts is another thing not common to the furniture industry. As H. I. Jackman, factory manager of one plant, said: "With this method of gluing parts we do in 1½ min. what it formerly required 3 hr. and 12 min. to accomplish." (Fig. 5)

The training of girls to make small assemblies, sew fabric on wings and varnish parts is progressing rapidly. Older craftsmen now do most of the planning and jig work.

Complete metal jigs are not used, except for drill guides. Instead, this industry uses heavy plywood bases. At one plant, all drill fixtures are covered with white-enameled pressedwood tops. Tops are held in place by the screws or bolts which hold the wood or metal clamps to the plywood base.

Formed plywood is used in many places. The trailing edge of the wing is one good example, the nosepiece another. Also many right-angle brackets handle corner bracing.

One assembly requires over 8,000

FIG. 3. Close-up of wing-assembling fixture. Angle iron brackets attached to the assembly buck locate each rib exactly. At this point the leading edge section arrives as a subassembly with the front spar. End bulkheads hold front and rear spars together while ribs are inserted and glued. When all ribs are in place the skins for one side are put on and glued to them. Note stock bins in the background at the side of the wing, and skin and rib supplies at the far end.

FIG. 4. When the woodwork is finished, wings must be covered with fabric. Scaffolds at left are used by the coverers. After the wings are covered they are guided on the monorail conveyor to the spray booth and doped. Then after drying and final inspection of fabric they are returned to the spray booth for their war paint. The down-draft water spray booth was made by the Grand Rapids Blow Pipe & Dust Arrestor Co. for this particular work.

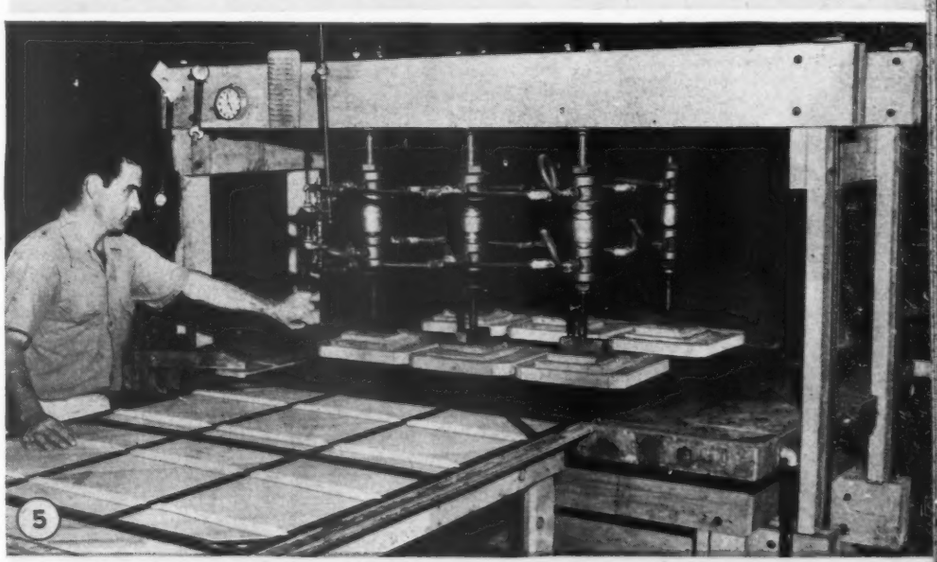
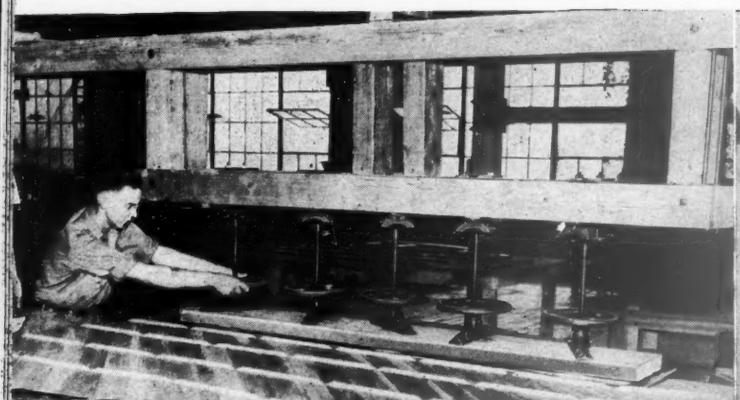
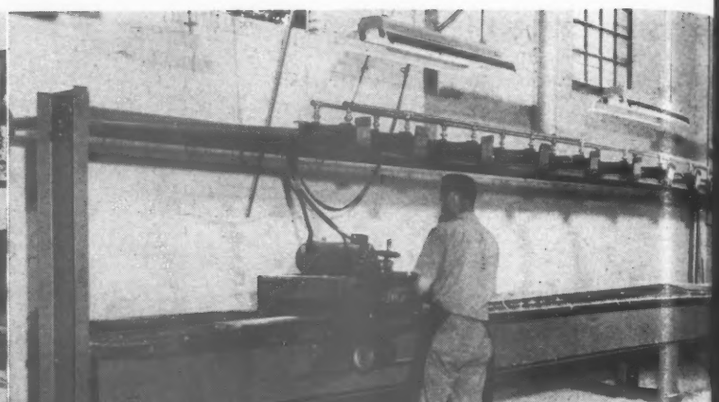
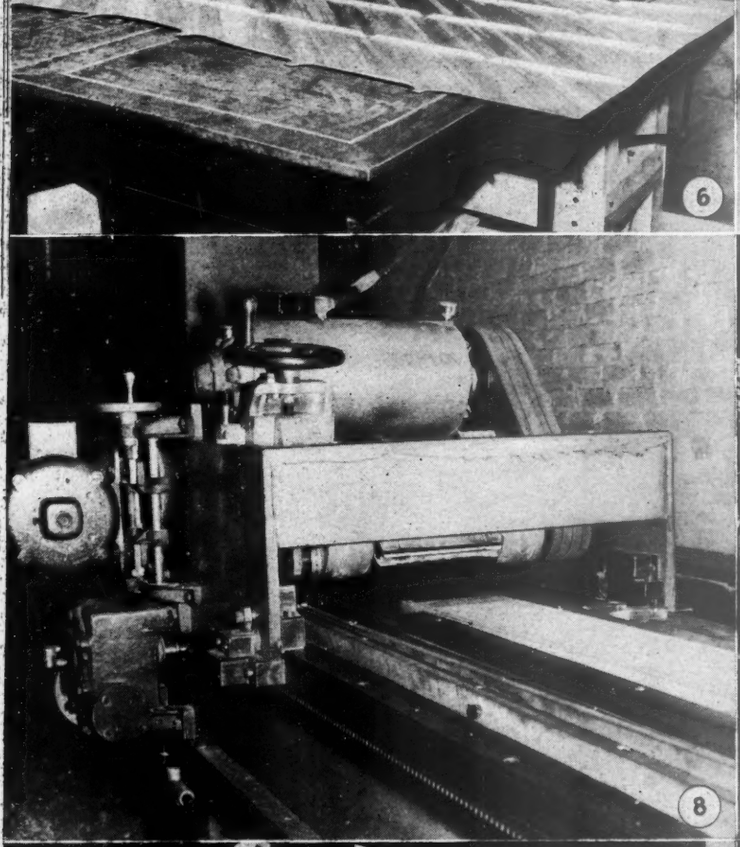
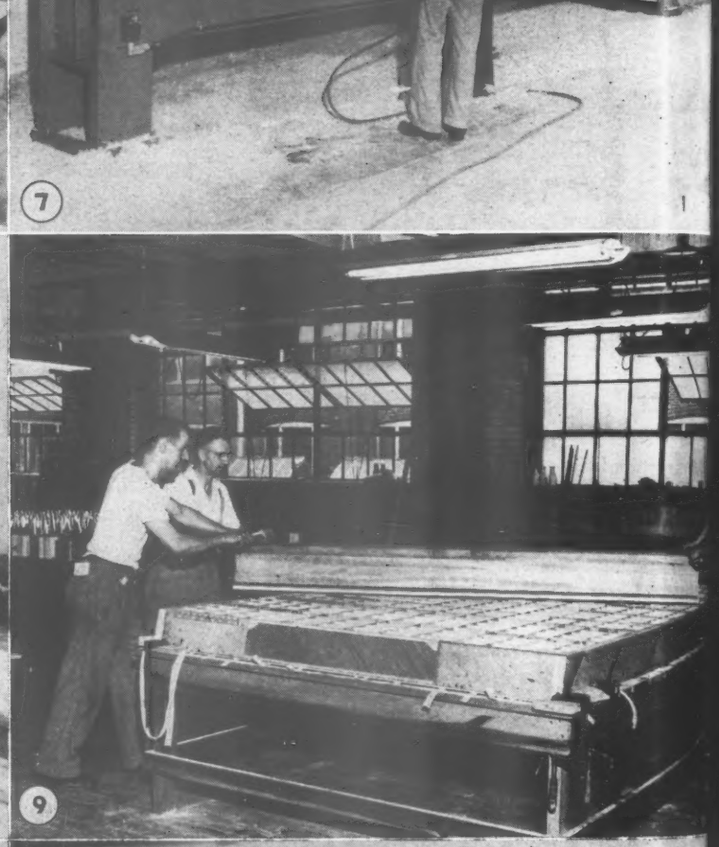


FIG. 5. All skins are reinforced with triangular strips between ribs. These strips are accurately spaced with a skeleton sheet-steel gage, shown in the picture, while they are being glued in place. Speed in getting into production made it necessary to build this press in the shop. A hot plate is used—taken from a veneer dryer—placed beneath the skin. Steam at 25 lb. determines the temperature of this plate. It cuts time from 3 hr. 12









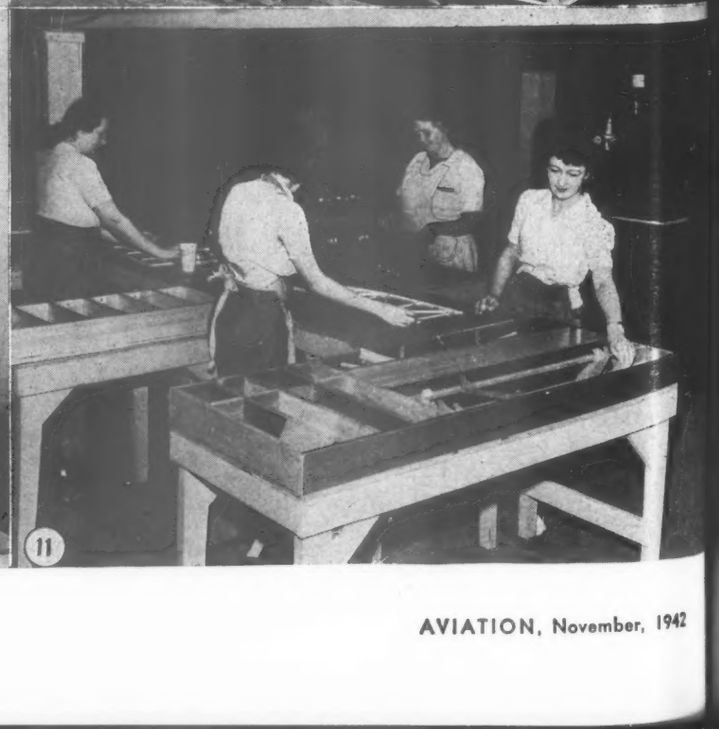


FIG. 6. Putting a reinforcing strip along the edge of the wing skins was another slow-drying job. Another steam veneer-drying plate and hand clamps cut the time to about 2 min. instead of hours. Note how the press is shoved up to the big overhead floor beams. This indicates the ingenuity used by these shop men in utilizing equipment and material at hand. . . . FIG. 7. An 18-hr. wing job was cut to about 10 min. by this special shaper, built especially by a local manufacturer, C. O. Porter Machinery Co. The machine was entirely electrically welded, and in record time. On it the main wing spar is completely shaped. Two different shaped spars are required, and this machine makes both. The two shapes are distinguishable by observing the contour cams on top of the machine and in front of the work. The shaper cutter is guided by these cams. Overhead are the No-Pak air clamps which press the spar tight against the table until air-operated toggle side clamps engage and hold it tightly in place while it is being shaped. . . . FIG. 8. Close-up of the traveling carriage on which is mounted the shaper head. The shaper is driven at 7,200 rpm. by belts from the overhead electric motor. The handwheel regulates the depth of each cut. The cam-follower roller is at the corner of the carriage. It can be indexed sidewise to ride on either longitudinal contour cam. The motor suspended on the side of the carriage drives the feed mechanism. The feed engages a rack beneath the ways. Not shown but to be added shortly is an electrically driven double saw on a horizontal arbor. This will size spars to exact width, while held by vacuum on a table parallel to the machine bed. Its top can be seen at the far right of this illustration. . . . FIG. 9. Sanding one unit, which looks like a huge honeycomb when finished. The sides are spruce, reinforced with mahogany veneer. The whole "comb" is set on a 1/4-in. veneer to which it is glued. Four men operate this huge sanding block, used before the top veneer is glued to the "comb." At the far left is a forest of clamps on a similar piece, glued and now drying. . . . FIG. 10. Typical of the

fine craftsmen who are working on these wings is Emil Gerritsen, who has been a cabinetmaker for 45 years. He has been a tool designer at this plant for over 25 years. Here he is building an assembly jig which holds parts in place while the cover veneer is cemented to them. All longitudinal strips are in place. They are accurately located by the little brass angles attached at intervals. Notice the hard-maple eccentric clamps on the side. Gerritsen has developed a rapid system of jig making. His base is 1½-in. plywood. On top of this he places 1/8-in. Masonite enameled white. On this he can lay out his entire fixture accurately. Notice he provides both right and left pieces on this fixture to keep production balanced. . . . FIG. 11. Here is a typical wing-rib assembly layout, showing two crews working, one on a left, the other on a right, rib. In the center is the glue roll—the operator putting on the glue for each rib-assembly group. In the background is the steam-heated gluing press with automatic time clock release. The man in the rear is just removing a dried rib from the press. Average drying time in the press is 1½ min. but without it, 3 to 4 hr. The bottom aluminum plate has small aluminum angles riveted to it. These angles hold wood parts and veneer accurately in position while glue sets. When the assembly is complete, a plain aluminum cover plate is put over it, and it is slipped into the steam-heated press. . . . FIG. 12. Here is evidence of efficient production methods. Every piece and stick that goes into an assembly is arranged and labeled in this department. Note how odd-shaped veneer pieces are not numbered, but stuck on the face of the drawers in which they are kept. Incidentally, these pieces are all die-cut in a press. Large pieces are on the shelves and small sticks of spruce in part-numbered pigeonholes.

FIG. 13. Women of all ages find this work very attractive. Here is one of Gerritsen's jigs in use. Girls are putting on the glue. Parts are inserted in the jig, then the mahogany cover veneer on the shelf below is put on top. Next, these jigs are piled one on top of the other and clamped. At the right, in the background, are stacks being dried, which takes about 4 hr.

pieces—all glued together and accurately arranged in a jig.

Work is carefully subdivided, and to control production and check the flow of parts a central warehouse is used by G.R.I. Into this go raw material, subassemblies and metal fittings purchased outside. From it they are distributed to plants as required to complete major subassemblies and finally to the plant making complete assemblies, ready for shipment. This warehouse is supervised by Army inspectors to expedite the flow of correct and inspected material to any factory in the G.R.I. group. It is considered one of the most important units in correlating the activities of so many separate manufacturing units and the key to the successful operation of this pool.

Frederick H. Mueller is president of G.R.I. He said: "Our furniture manufacturers tried individually to get aircraft work without success. The Furniture Association tried to get aircraft work, to no avail. Individual factories were too small, the association was a committee organization that could not make contracts. We wanted to do our bit toward winning the war, but could not seem to get anywhere. Then Grand Rapids Industries, Inc., was formed.

Every member of the Grand Rapids Furniture Association was invited to participate. Representative companies in this association got together, paid in $100,000 in cash capital. These firms together represent resources of over $10,000,000. This put their factories in a position to subcontract with anyone. We got our orders for gliders in May and were making deliveries within 90 days. The really big problem we had was not facilities but how to organize them so that they could do business with the government. We have been told that this set-up is a model one and we appreciate the compliment."

Stephen F. Dunn, secretary of G.R.I., stated: "We followed a special WPB procedure in forming the G.R.I. We are joined together for war effort only. The furniture side of our business is still run on as highly a competitive basis as ever. The important thing about our set-up is the agreement that each member 'will render their productive facilities available for the manufacture of products, or parts thereof, described in or covered by any and all contracts or subcontracts for war work obtained by said G.R.I.' It is working out most successfully. Perhaps this is because there is no promotional stock in the organization."

FIG. 14. After pieces shown in Fig. 13 are glued, they are given two coats of spar varnish. Great care is required because a cover veneer goes on part of this bulkhead, and glue will not stick on a varnished surface. Hence, each varnisher must be very careful not to get varnish on a surface where glue is to be applied. Special drying racks are shown in the background. These hold bulkheads so that they will dry properly and rapidly and yet not touch one another. . . . FIG. 15. Cover pieces for bulkheads are thin veneers accurately die-cut to size and given a couple of coats of varnish. Masking tape is carefully applied to surfaces to be glued so varnish will not prevent glue from sticking. Then the operators can varnish rapidly without hesitation. Pieces are dried on the line in the background, where they look like butterfly wings. . . . FIG. 16. Here is a sample of Gerritsen's idea of making a drill jig with the minimum of metal parts. He uses toggle clamps to hold the work in place. He is particularly conscious of the steel shortage, so he uses maple blocks under steel drill-bushing plates wherever possible. In the foreground he uses steel supports, because they are hinged to allow work to be inserted in the fixture. All drilling is done with portable electric drills. Drillers are taught to keep the drill running and lower it through the drill bushing with both hands. The weight of the drill is all that is necessary to sink it into the wood. The entire fixture is built up on a 1½-in. plywood base topped with an ⅛-in. pressed-wood top lacquered white. The pressed wood is not glued to the plywood; only the fixture bolts hold it in place.

Developing Graphic Illustrators

"Reverse" approach to personnel problem proves advantageous in creating isometric drawings for production and service line workers.

By R. R. WIESE

Assistant Executive Engineer, Fleetwings, Inc.

IN AN INDUSTRY such as aircraft manufacturing, which has grown to huge proportions almost overnight and which is in such dire need of experienced personnel, it is a windfall to strike a source of manpower which has been heretofore largely untouched by war production plants. In the development of its graphic illustrations department, Fleetwings has found just such a source.

At the outset of the emergency a number of aircraft manufacturers recognized the value of providing graphic sketches—more technically, isometric, three-dimensional drawings—rather than relying wholly upon mechanical drawings of but two dimensions.

"But who will we get to make these sketches?" they asked. "Draftsmen—even though they may be first-class detailers—are trained in working in two dimensions and are therefore not prepared to tackle the graphic sketch work—that is, without further art training."

The result was that these companies decided to select some of their own outstanding draftsmen, send them to art school for training in three-dimensional, perspective illustrations, and then assign them to the new work. Here at Fleetwings the reverse approach has been used, and used with unusual success.

In establishing the graphic illustrations department, it was realized that for every draftsman lifted from the rolls a replacement would be needed. Where, then, could replacements be had? Draftsmen are scarce. We realized too that much valuable time would be lost while the man was spending three to six months in an industrial art school learning how to wield a facile hand in three-dimensional work. Upshot of that thinking was to scrap the conventional approach and start out on a pioneering tack.

It was decided to employ full-fledged commercial artists, men who had previously been engaged in advertising agencies, department stores, or independent art organizations. The fact that these men were relatively unfamiliar with reading blueprints proved no deterrent at all. As John Gonzales, leader of the department, observes, "Our practice has been to take artists whose work shows attention to detail and reflects ability to work 'close' as well as a thorough understanding of perspective. Blueprint reading can be taught in less than two weeks. An artist is naturally able to visualize, and once he has learned to understand engineering drawings, it becomes fairly simple for him to render pictorial views from blueprints. Teaching a draftsman to draw in three dimensions is a much longer process than the simple procedure of explaining blueprint reading to an artist."

The significant aspect of this approach has been that it has led to the tapping of a personnel market which is readily available, particularly so in view of the curtailed activity that artists have experienced since advertising budgets of many former large scale civilian goods manufacturers have been slashed.

Fleetwings has, like many other com-

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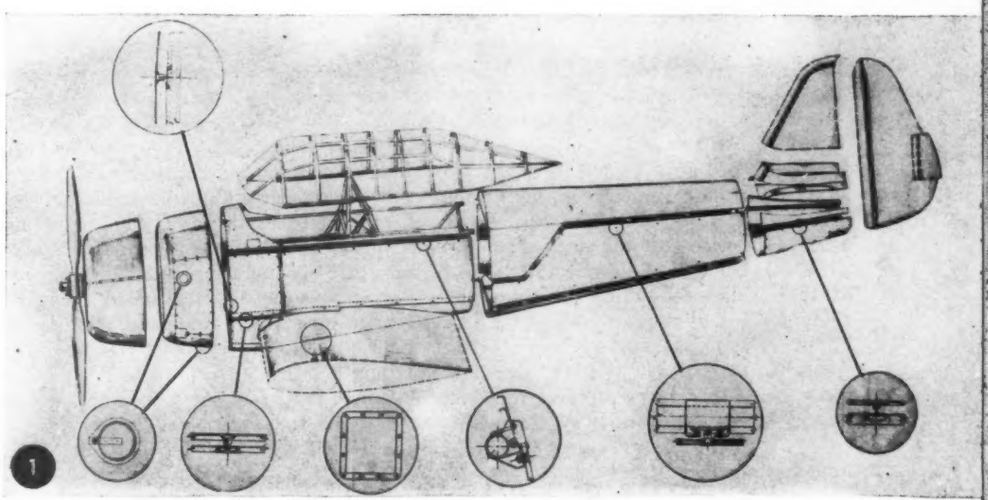
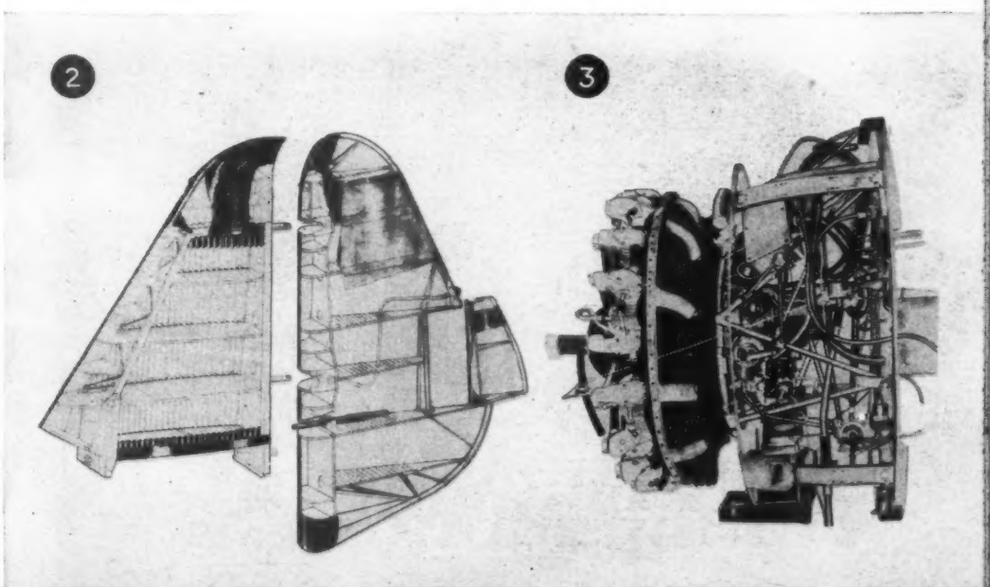


FIG. 1: For the commercial artist turned aircraft illustrator, an exploded sketch such as this one of the Fleetwings BT-12, might be the first three-dimensional assignment. FIG. 2: The average artist working on isometric drawings is usually able within six weeks to illustrate aircraft subassemblies showing complete detailed construction. This drawing of a tail unit is typical of such work. FIG. 3: This complex-looking drawing is the work of an advanced graphic artist. Any slight changes that might be required are usually handled by new members of the department as one means of speeding their training.



DESIGN CONSIDERATIONS For PLYWOOD STRUCTURES

The first in a series of vitally important articles setting forth fundamental information needed by every designer of plywood aircraft. This article is an "orientation" piece outlining the fundamental characteristics of plywood from a design standpoint.

By **L. J. MARHOEFER**, *Chief Engineer, Vidal Research Corporation*

DESIGN of any structure must be based on a clear understanding of the characteristics of the material being used. While most of the early airplanes were constructed of wood, the advent of thin wall steel tubing and high development of aluminum and magnesium alloys has, until recently, resulted in wood being pushed well out of running as a prime aircraft structural material except for light, "consumer" aircraft.

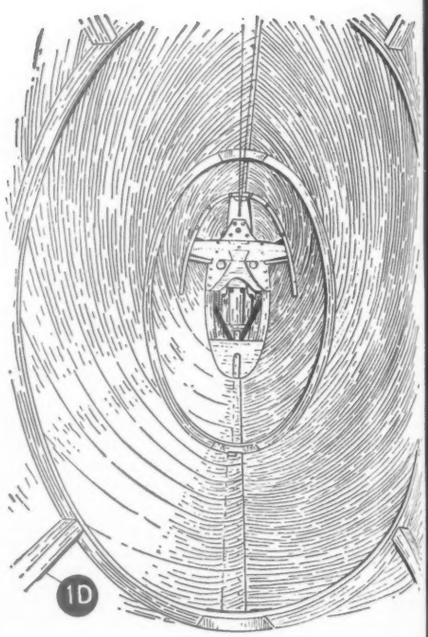
It must be stated at the outset that the present war has had little to do with the reincarnation of wood as applicable on an important scale to aircraft construction. This development has been growing for a considerable period and reached a highly practicable stage prior to the war. The war has resulted in an accelerated interest because of the apparent imminence of metals shortages, but of more importance it has resulted in an intensified study of wood as a structural material because the most practicable material or combination of materials is being sought for aircraft to win the war—and for post-war aviation.

It should be further stated at the outset that full advantage cannot be taken of a material of particular characteristics by employing design criteria established for materials of different characteristics. To put it bluntly, metal airplane design cannot be applied to wooden airplane construction rib for rib, or stringer for stringer, with any full degree of efficiency.

The fundamental characteristics of wood as given by the Forest Products Laboratory, and accepted as standard for design, are well demonstrated by using aircraft spruce as typical. This material is non isotropic with a poor moisture resistance. It has a low density (approximately 0.45), a good value of tensile strength parallel to the grain, and reasonably good compressive strength. One of its most serious shortcomings is its low shear strength, which compared to its own tensile strength is a ratio of 750:10,000, whereas 24 ST Dural has a ratio of 39,000:65,000.

The low value of shear strength and tensile compressive strength perpendicular to the grain is overcome by cross banding veneers to provide a more nearly uniform strength in both directions. This is plywood. Basically, the strength of the wood remains unchanged by the cross lamination, but the fibers in action under load are different. Obviously it is possible to provide almost equal strength parallel and perpendicular to the face grains by adjustment of the thickness of the cross bands and face layers.

The suitability of wood as an aircraft material is well attested by the many aircraft constructed of wood. Its durability when properly protected from weather is demonstrated by the number of Lockheed *Vegas* still in service, for example. True, the wood has been sliced into pieces of veneer and put together again as plywood, but these steps of slicing, lamination and bonding are not nearly so involved as the torture to which a molecule of aluminum is subjected between its natural state and its incorporation in a finished airplane.



Meeting the Test of Shear

The reason that low shear strength values of natural wood is a most serious shortcoming is that in the joining of various parts of a glued structure, the shear characteristics are involved, primarily. Acceptable stresses on glue joints were formerly taken as only 250 psi. for important structural joints and the handicap imposed on heavily stressed joints using flat plywood and corner blocks is obvious. This disadvantage has been overcome, so far as weight is concerned, by the fact that *molded* veneer may be bent to as sharp as $\frac{3}{4}$ in. radius, and a wide glue surface provided without the use of a corner block (Fig. 2).

Another type of shear commonly en-

countered in aircraft structures is in a thin web carrying shear between beam flanges. Current practice in monocoque design uses such thin skins, essentially incapable of resisting compression loads themselves, but performing the function of shear ties between rigid structural members. The discovery that thin metal panels can buckle under load without exceeding the elastic limit of the metal has, in fact, made possible the current monocoque metal structures. If only narrow bands of thin metal were available it would be still possible to construct monocoque webs provided the bands were run at approximately 45 deg. to the structural axis and a double layer of bands were used at 90 deg. to

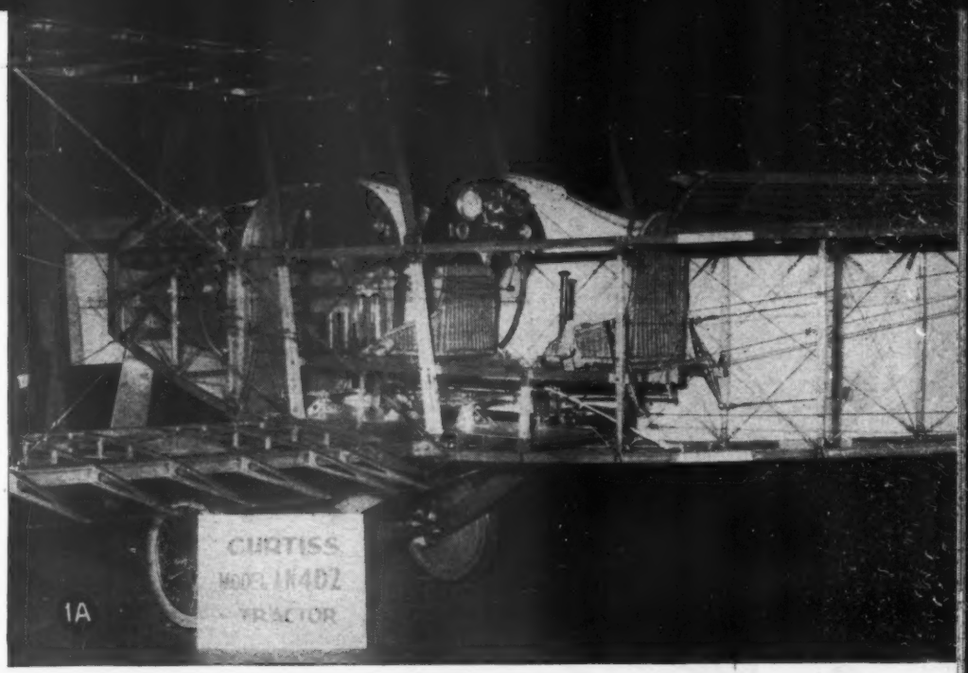
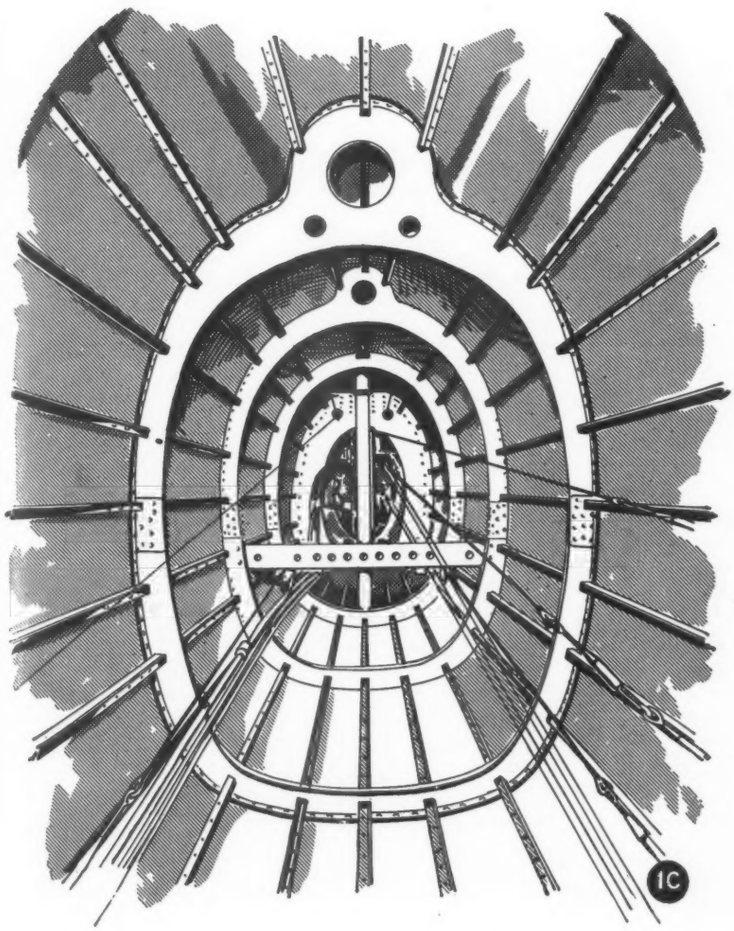
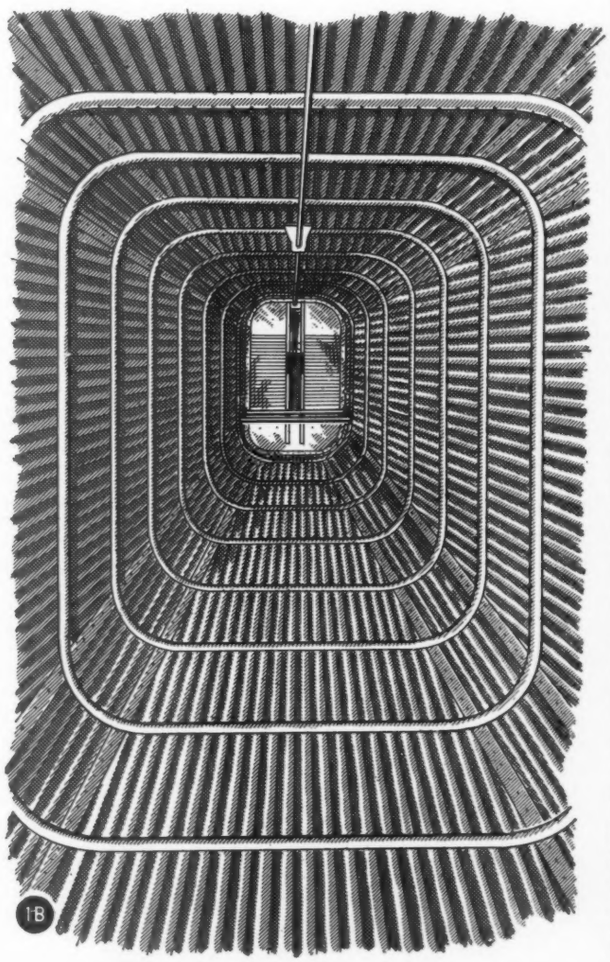
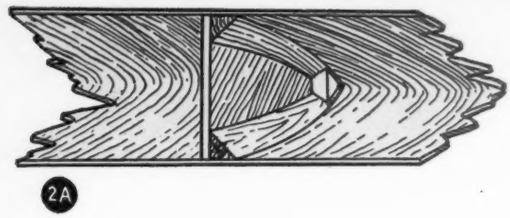


FIG. 1. The four principal stages of materials-design development. (a) The wood, glue and nail era—a Curtiss JN4D2, built by the thousands during the first World War. (b) Metal—first phase. Monocoque-type construction with corrugated sheet metal in a Pittsburgh Metal Airplanes Company's "Thaden" T-4-A monoplane, 1931. Corrugated sheet was used before the discovery that thin metal panels could buckle without acquiring permanent deformation. (c) Metal construction in its current phase. Fuselage of the Vought-Sikorsky V-143 utilizing thin, smooth sheet metal in semi-monocoque construction. (d) Reenter wood in the form of molded plywood. The "Summit" HM-5 fuselage of monocoque-type construction using thin plywood sheet molded integrally with structural frame members.







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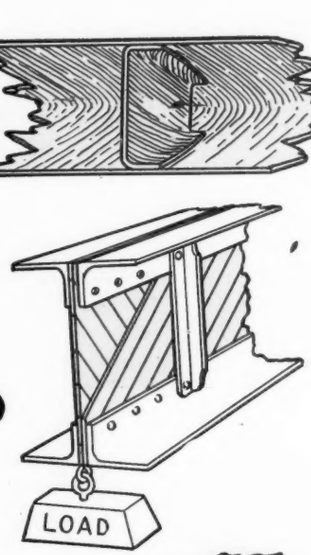

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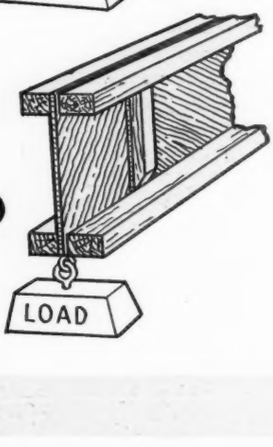

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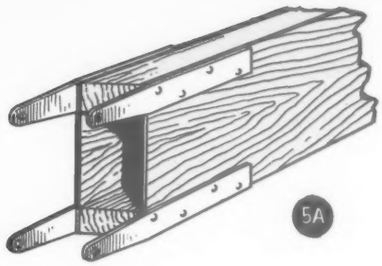

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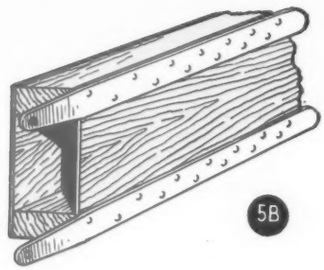

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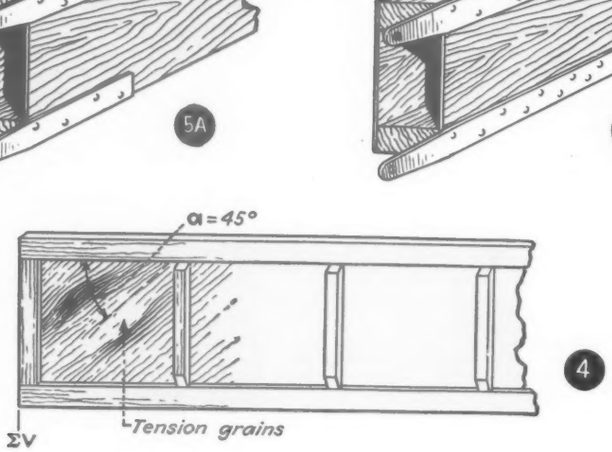

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FIG. 2. A serious handicap is imposed on heavily stressed joints using flat plywood and corner blocks. A substantial weight saving and more satisfactory glue area is provided in the modern molded plywood construction in which veneers may be bent to a 3/16 in. radius.

FIG. 3. In the case of a thin web carrying shear between beam flanges, plywood acts similarly to metal sheet and is capable of the same performance. (a) For purposes of analogy, the metal sheet is assumed to be made up of narrow metal bands running at 45 deg. to the structural axis. This assumption can be made on the basis that the axis of the temporary deformation shape due to the buckling runs at approximately this angle.

FIG. 4. If the grain direction of the plywood web or skin runs at 45 deg. to the shear plane it will buckle into waves similar to the "Wagner" tension field.

FIG. 5. In natural wood construction, assembly joints are unreasonably complicated and heavy where double shear members are used, and a considerable number of bolts are needed in a single shear fitting.

WITH THE TREND toward plywood aircraft construction gaining powerful momentum there is a vital need for fundamental design information to be disseminated. Design criteria applying to metal structures do not always apply to wood construction. In order to obtain the maximum usefulness of plywood as an aircraft material, it is necessary to design specifically to plywood characteristics at its present stage of development and workability. Therefore, full consideration must be given these factors and new criteria established.

* * *

AVIATION is proud to meet this need through the authorship of one of the country's leading authorities in the field who has probably done more to bring the art to its present stage of development than any other single individual.

each other. Disregarding efficiency for the moment, it is apparent that a shear web so constructed, and with proper vertical stiffeners is capable of carrying load (Fig. 3).

Wood veneer, due to the low tensive-compressive strength perpendicular to the grain, is reasonably approximated as such a series of quite narrow bands. If the grain direction is arranged at approximately 45 deg. to the shear plane it might be expected to behave in a manner similar to the metal-band shear web. In the case of quite thin webs, (t/h 0.006), this is readily proven. In this t/h range, the web or skin will buckle into waves similar to a "Wagner" tension field (Fig. 4), and a good approximation of the web strength is obtained by similar treatment. Neglecting the compression grains, which buckle quickly out of action, the shear is carried by the diagonal tension veneers alone.

Actual webs have usually been designed on about 60 percent of this value and the complete lack of web failures indicates it to be too conservative.

For values of t/h beyond the buckling range this treatment is conservative since there is then a condition of compressive as well as tensive fibers transmitting shear. Insufficient data are available at this time to permit close design of thick webs. Webs designed on the basis of tension material only in action have provided no test failures as guides, although one quite heavy, curved web has stood up under shear stresses in the vicinity of 2,500 psi.

It might be noted at this point that diagonal tensive stresses in webs approximate handbook values within the expected wood variation. Tensive stresses in stringers and flanges have, on the other hand, shown a distressing inability to read handbooks.

Assembly Joints

Another serious difficulty in wood construction has been the provision of joints permitting assembly and disassembly for shipment, and the inevitable replacement of broken or worn parts. Sound practice in early wood aircraft involved the use of sufficient bolts bearing on the wood to transfer loads involved from the wood to the metal fitting. Due to the unusually large thickness of wood members, attachment by means of pins in single shear resulted in an unreasonably large number of rivets or bolts. Provision of double shear members entailed considerable complication in the fitting design and an unreasonable weight penalty (Fig. 5).

At least two recent advances in the art of joining metal to wood give promise of overcoming these disadvantages. While they are rapidly being reduced to practice, information on them is not releasable at this time. The possibilities and vistas inherent in these efforts to solve joint problems give promise of new combinations of materials hitherto as incompatible as oil and water. The progress, even at this early stage, has carried far beyond the solution of the original problem.

Moisture Resistance

The problem of moisture resistance and dimensional stability has been attacked from two standpoints. The first has involved the use of protective coatings on finished surfaces and has revolved around the development of adequate painting schedules. Present schedules give moisture absorptions of 5 percent after prolonged immersion. The second method involves impregnation of the veneers and results in very much improved moisture characteristics. Almost any degree of resistance may be achieved by this method. This impregnation procedure results in an appreciable increase in cost and has not, for this reason, been as widely utilized as had originally been expected.

Gluing Agents

The discarding of wood as a structural material by the aircraft industry was hastened by the fact that the only glues available twelve years ago were of animal or vegetable origin. A number of unfortunate accidents were traced to glue deterioration and the ban on the use of these glues effectively stopped production of many wood airplanes.

The objectionable characteristics of these glues have since been overcome by the development of synthetic resins which have such high durability and good adhesive properties that a powerful interest has been revived in aircraft relying principally upon wood for its structural integrity. The progress made at the outset was instigated by the development of plastic materials polymerizing at sufficiently low temperatures to be used for bonding veneers. These materials had in each case an extremely low moisture absorption, apparently permanent life, high resistance to fungus, and the ability to use heat as a catalyst in completing polymerization. This latter characteristic is perhaps the outstanding advantage of these synthetic glues since it became possible to obtain perfectly bonded pieces in a matter of a few minutes whereas it formerly was necessary to maintain clamping pressures for a minimum of 6 to 8 hr.

Even to the unskilled in production it was obvious that a long setting time involved either heavy duplication of clamping jigs or an unwieldy "gluing bulge" in a production line. This "clamping bulge" was so real as to relegate wood to a place in industry largely confined to non-production items and places where nailed joints were considered satisfactory. Cutting this "bulge" from the production line became possible with a glue which could be set in a matter of minutes. Recognition of the production made possible by this advance has turned the eyes of the industrial world toward possible new uses for plastic bonded materials in every field.

Transition Cycle

By the time wood construction seemed doomed to be forever shackled by these inherent disadvantages, the art of designing aluminum monocoque structures had acquired sufficient background to permit its rapid adoption. By no means could it be said that all of the metal structural problems had been solved. Lack of adequate strength data was a constant stumbling block, in fact until quite recently. Protection of the metal against corrosion was a serious problem. Inevitably, many of the early designs were detailed copies of the wooden forebears with changes in part thickness and the use of rivets in place of glue and nails.

The progress from corrugated to smooth metal was hastened by the discovery that thin metal structures could buckle without acquiring a permanent deformation. With this point widely accepted, the departure from wood structures was quite rapid. Unsolved was the cumbersome problem of joining metals with rivets where they could not be safely spotwelded. Unsolved also, remained the problem of eliminating drag due to shear-compression wrinkles so detrimental to high performance. Their acceptance is not proof of their desirability or necessity.

Considering the materials with which we can work today, as well as the conditions of the times, it is unfortunate that the use of wood did not share in the tremendous expansion of the aircraft industry. Design personnel entering the industry during this period have been trained chiefly in the characteristics of sheet metal and shops have been tooled for the production of metal aircraft.

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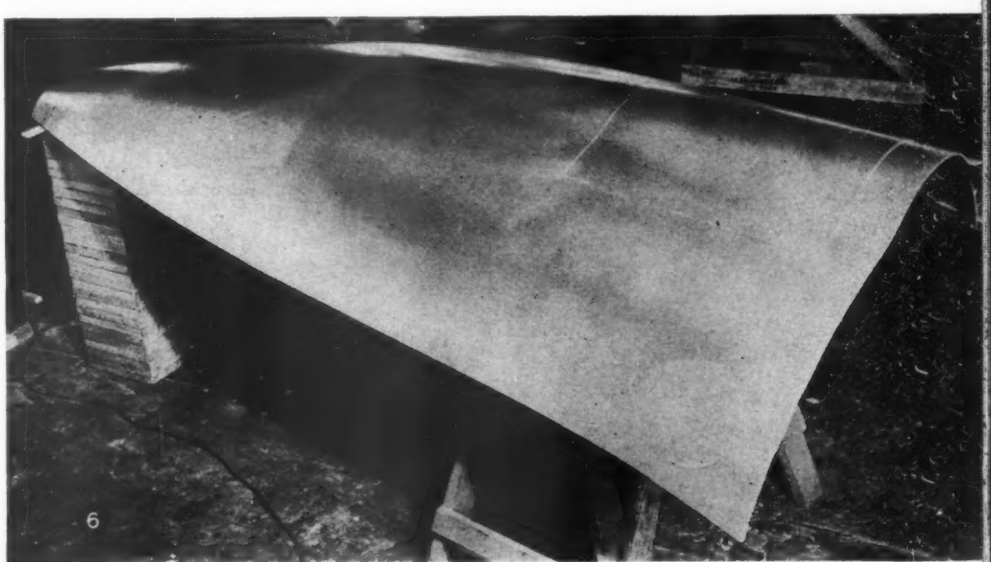


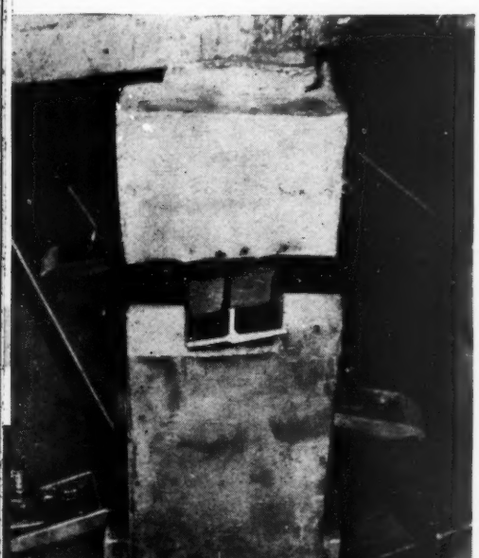
FIG. 6. Molded plywood airplane construction is simpler than corresponding metal construction. It is easier to attain a clean smooth assembly such as the molded engine nacelle fairing shown here.

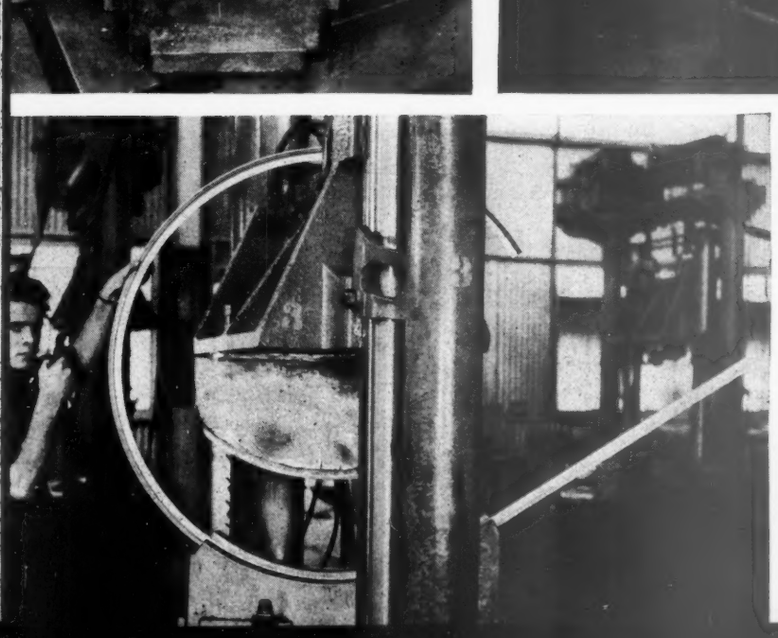
RANGE OF DROP HAMMER OPERATIONS

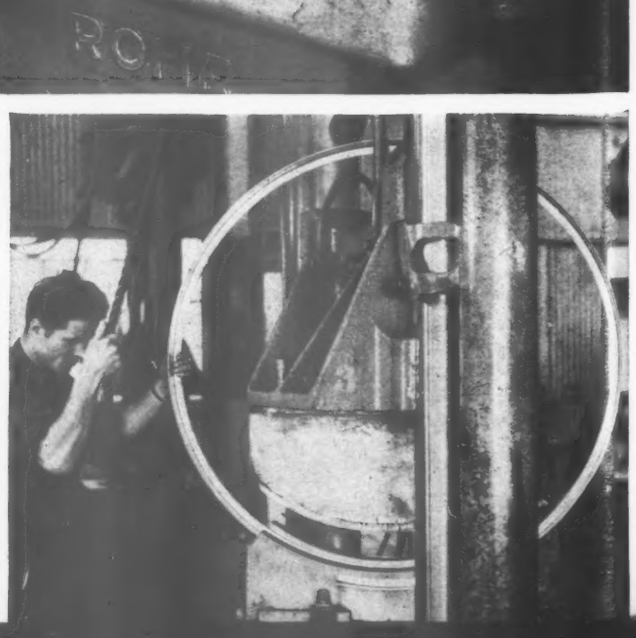
While frequently it is assumed that the thinner the gage of sheet metal the easier it is formed by drop hammer methods, just the reverse is more often the case. The authors explain why, and offer new suggestions for more efficient utilization of drop-hammers.

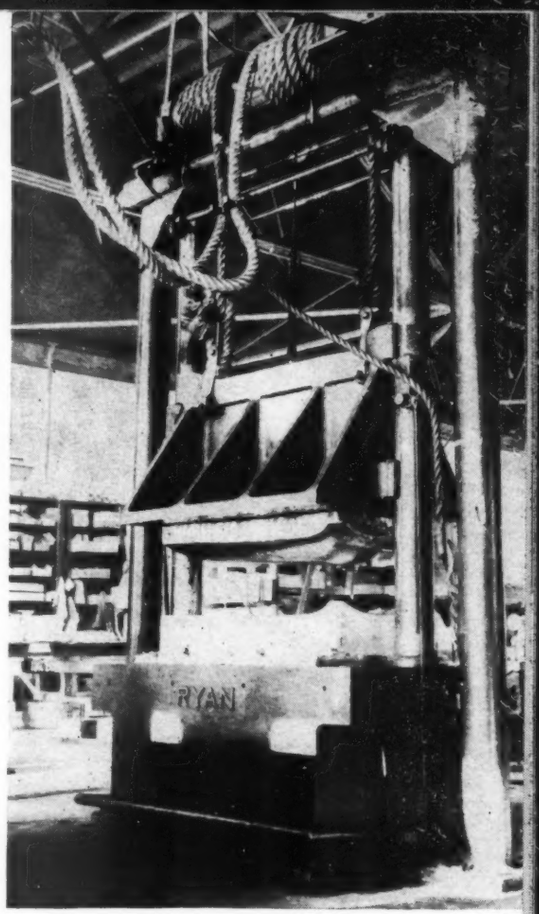
By CHRIS J. FREY, *Brewster Aeronautical Corporation* and STANLEY S. KOGUT, *Eastern Aircraft Production Forum*

The group of photos below illustrates successive steps in shaping an aluminum extrusion into a perfect circle, utilizing a drop hammer. It is accomplished by a series of operations, each of which forms a part of the arc of the projected circumference that finally becomes the circle. As the blows of the hammer shape the part to the dies, the extrusion is fed in further. Note that this method cannot be practiced unless the part to be formed represents an arc of a perfect circle whose diameter is greater than the hammer bed. (Rohr Aircraft photo).









Drop hammer at right is typical of those used in forming large panels of aluminum and its alloys for aircraft structures. (Ryan Aeronautical photo).

BECAUSE OF THE SEVERAL elements involved in drop hammer operations, and the varied relationships between them that occur, it is not possible to lay down any rule of thumb by means of which it can be determined whether or not it is practical to manufacture a particular part by that method.

The following factors, however, are important in determining the feasibility of drop hammer technique for a particular job.

1. Type of material and its quality.
2. Is it heat treated?
3. The compound curvatures or intricacies of shape.
4. The size and weight of the hammer on which it is to be made.
5. The dimensions of the part.
6. The tolerances permissible.

Not all materials lend themselves very easily to drop hammer work; particularly the type involving deep draws. It cannot be too thin or it will buckle too easily and unless its yield point is low enough, it will buckle before shrinking. It is good practice to try and prevent buckling from starting at all. The method of hand hammering out buckles to eliminate preliminary wrinkles really starts a vicious cycle. Working of the sheet by the hand hammering (or any other method) raises the compressive yield point. Merely working the sheet is enough to do this. When the compressive yield point is raised, the tendency toward wrinkling increases with it. So it continues. Each application of force to remove a buckle makes the sheet more likely to buckle in the future and that much harder to shrink.

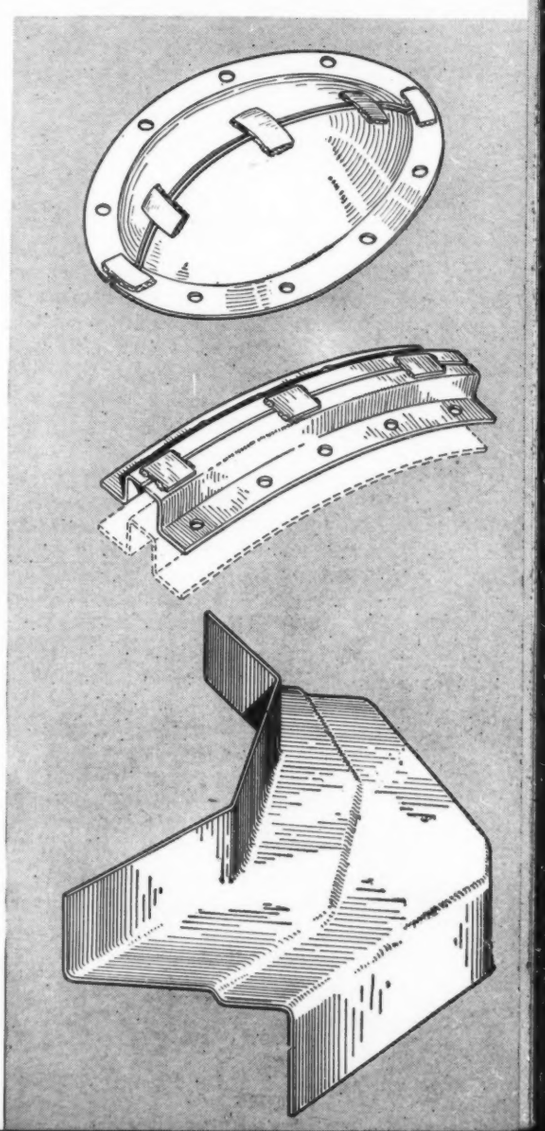
Aluminum and its alloys are the materials on which the greatest portion of aircraft drop hammer work is done. While 24SO is used for the majority of all work, the best results are obtained with 3S, 3S½H, 2SO and 52S and these four are accepted as being the preferable grades for drop hammer work by aircraft manufacturers.

While, offhand, it might appear that the thinner the gage of the metal, the less the effort necessary to shape it into the desired form, this is not the case. Many parts cannot be made in 0.020 that can be made in 0.040. Not too intricate parts of 0.025 can be stamped out if great care is used in the procedure. From this point the tendency to wrinkle will increase as the gage of the material is reduced, to such an extent that the manufacture of aircraft parts by drop hammer methods from thinner sheets is impractical because of the care, time and effort necessary to remove wrinkles. The deeper the draw and the more compound the curve, the greater the tendency to wrinkle. As a general rule, it may be said gages of 0.025 can be drop hammered in production in simple shapes. As the gage becomes heavier, more intricate shapes can be made successfully. Material as thick as 0.051 forms readily but the gage most used is 0.032.

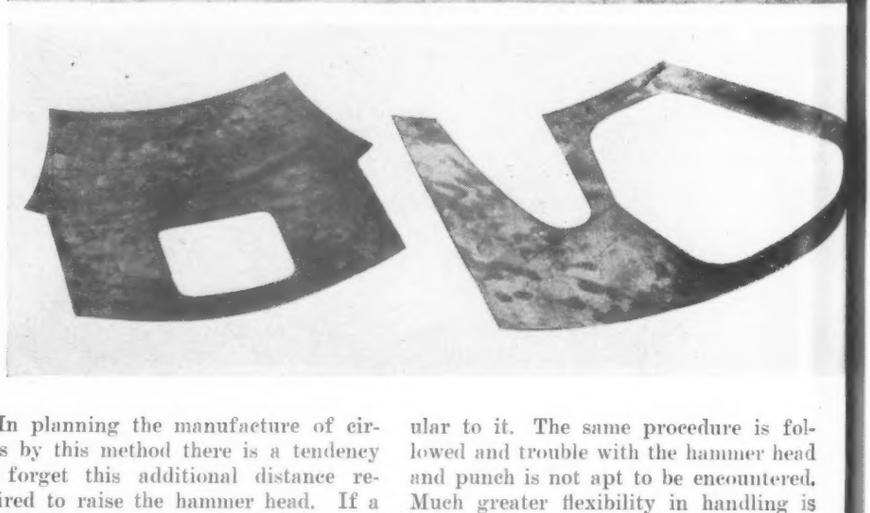
The manufacture of stainless steel parts in a drop hammer was not feasible until about ten years ago. The customary pure zinc dies used in those days could not stand up under the sledge hammer blows necessary to form stainless steel. Even under the most satisfactory conditions, the life of the lead punch was short. The use of zinc alloys, steel, and cast iron alloys, all harder materials than zinc, for the female die, is an economical measure and has expanded the range of the drop hammer. These harder materials are used for the punch also.

In the old days, a wrinkle in a stainless steel sheet from which a part was being made spelled tragedy. Since the steel was so much harder than the lead, each blow of the hammer head served to impress the wrinkle more clearly into the punch rather than out of the sheet. Nevertheless, simple parts were formed out of light gage steels with the conventional lead punch and zinc die. These metals must give way to Kirksite and the new superior zinc alloys when either an intricate shape or a heavy gage of stainless steel must be formed. Any material having the durability and general characteristics of these alloys will be satisfactory.

There are certain limitations which determine the actual size of a part that may be manufactured on a drop hammer. The size of the punch necessary to form a part may be sufficiently large so that its weight is too much for the



The two top sketches in panel at right are examples of galvanized trim and drill templates made in drop hammer dies. Note that shells have been split to obtain correct fit over parts and then tack-welded together. Part illustrated in the bottom sketch was made by Miller and Doing Co. in 0.040 gage satisfactorily, but was found impossible to form in 0.020 because of wrinkling.



hammer head to carry. The bed of the hammer may be smaller than the part to be formed. The intricacy of a compound curvature or severity of the draw may be such that the hammer does not have sufficient power to form the part in a manner suitable for a production run. This is apt to become increasingly important as the size of the part increases to where it approaches the size of the hammer bed. It is possible, in certain instances, to form parts whose size is greater, even several times greater, than the bed of the hammer on which they are being formed.

Bar metal, or extrusions in long lengths can be shaped into complete circles or arcs of circles whose diameters or arcs are much larger than the bed of the hammer on which they are formed. A fully circular piece may be manufactured by a series of operations, each of which forms a part of the arc of the projected circumference that later becomes the circle. The bar stock is fed into the hammer by degrees of length. As the blows of the hammer shape the part to the dies, the bar is fed in further. The finished arc leaves the hammer and straight material replaces it and so on. Unless the part to be formed represents a perfect circle or an arc of a perfect circle this method can not be practiced. The diameter of the part to be formed must be larger than the hammer bed or this method cannot be used.

This practice is somewhat restricted by the shape of the hammer used and the location of its posts. This method cannot be used to make small circles because the diameter of the circled part must be sufficiently great to go from the bed of the hammer over the top of the hammer head carrying the punch plus the additional distance the head is raised in order to strike the blow.

In planning the manufacture of circles by this method there is a tendency to forget this additional distance required to raise the hammer head. If a part is less than half the circumference of a circle it presents no particular problem of this nature. The part is apt to be completed before its forward portion (the first part formed) reaches a point where it may interfere with the normal action of the punch. Where the shape of the part and the arrangement of equipment permits, a radial piece can sometimes be formed in a position parallel to the floor rather than perpendicular to it. The same procedure is followed and trouble with the hammer head and punch is not apt to be encountered. Much greater flexibility in handling is permitted.

Long, straight pieces can be formed without any restriction, regardless of their length, provided there is no obstruction on the plant floor to hinder them. This offers no particular problem. The bar is fed in at a rate sufficiently slowly to permit it to be shaped.

The drop hammer is by no means a precision instrument, but parts manufactured by the drop hammer method

At top, left, are Ryan exhaust manifolds made on Kirksite dies of Inconel (Ryan Aeronautical Photo). Left, center, illustrates some of the many parts fabricated on drop hammers at Vultee (Vultee Aircraft Photo). Left, below, are skin sections formed on Cecostamp after preblanking the openings by the rubber die method. Sketches at right illustrate sequence of operations in forming and trimming sheet stock in the drop hammer.

conform well within the limits generally allowed for sheet metal work; although with the dies commonly used, they do not measure up to the tolerances that can be held by a press. Where great accuracy is required of a drop hammered part, the use of steel dies, or even only the use of steel inserts (called armoring), will satisfy most stringent requirements.

In comparison with other types of forming machinery and methods, the drop hammer is an exceedingly economical machine to use since the die stocks represent only a capital investment. They can be remelted and reused. Particularly where only a few pieces of a particular part are needed does the drop hammer come into its own. Where these parts need considerable shrinkage, the balance is even more in favor of a drop hammer. Since hammer blows have a tendency to eliminate the strains set up in metal, the drop hammer method is ideal where a condition of spring back exists. It has no difficulty with deep draws and can make parts without difficulty where the radii are not too small or the corners too sharp. Wing tips, fairings, cowlings and nose ribs are excellent examples of the type of part within the range of the drop hammer.

Blanking

Certain parts can be formed on a drop hammer and then trimmed by a second operation. Very often the possibility of shearing by a drop hammer is overlooked. The type of die used is slightly different from an ordinary operation in that it must have a cutting edge along the line where the trim is to be made. In most cases, the metal out of which the die is cast will have the necessary qualities for cutting. This edge must be placed in such a way that the success of the first forming operation is not affected. That can be done without great difficulty. The first operation may consist of more than one blow of the hammer, and is used for forming alone. The sheet is not forced against the cutting edge at all during this first operation, and the shape of the punch will insure its assuming the correct contour.

The punch is then raised so that it is generally not necessary to remove the part; and the placing of blocks of rubber on the sheet over the cutting edge enables the operator to blank the part by the pressure applied to the rubber in the next few blows of the hammer. The use of a rubber blanket for this purpose is very often unsatisfactory—some authorities to the contrary notwithstanding. The force of the hammer blow distributed over the area of a single piece of rubber, having several times the surface area of two rubber blocks, cannot possibly be as effective as the use of two blocks correctly placed. The blow must be localized.

Rubber, when under pressure, flows almost like a fluid. The blow of the hammer creates pressure on the rubber causing it to flow in the direction of least resistance. This is bound to be up against the part of the sheet that is not backed by the die and in this way the part is forced against the cutting edge.

Cutting in this manner is much faster then using a trim template, and a band saw. The final blow of the hammer given during this blanking process also insures correct contour. A slight burr is felt by this operation that can be removed easily by hand.

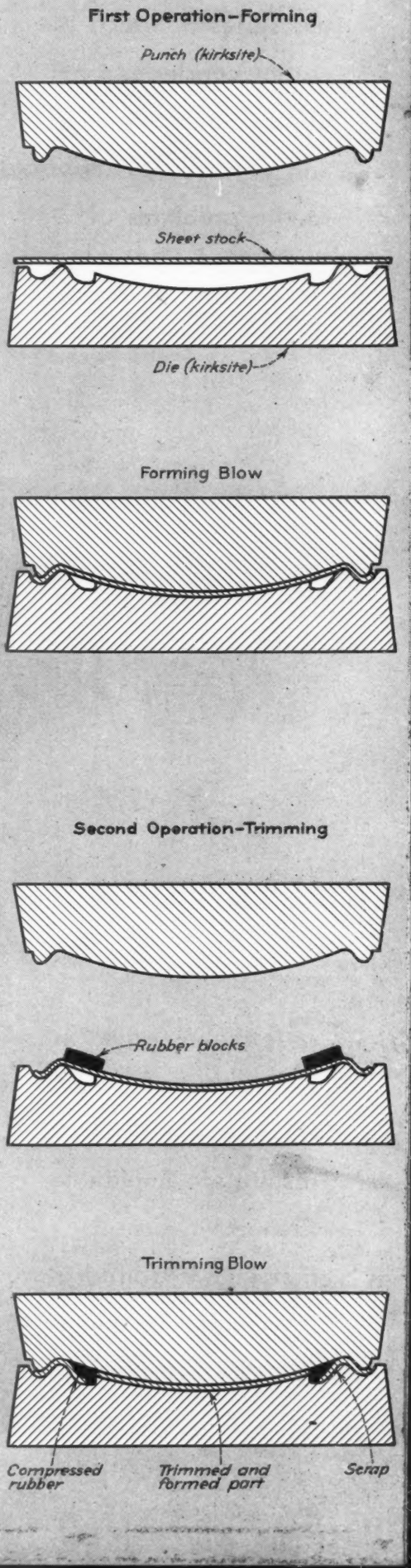
This type of shearing can only be used on fairly flat work. For trimming a deep drawn part a marking template is made from a piece of galvanized sheet. After the part is marked it is trimmed on a band saw.

For pieces with compound curves, such as a section of fuselage skin or a cowl panel, forming grooves may be used around the edge of the die to great advantage. (See sketches on page 121). These definitely locate the metal and keep the piece from springing back or jumping around. In this way the blows are struck in the same place each time and their force is not dissipated. This is a most important modification of dies usually used which provide no sure method of holding the part in place.

Trim and Drill Templates

Shells for trimming and drilling templates are stamped from galvanized sheet metal in the same dies as the parts. In order that the galvanized template, may fit over the parts to be trimmed, it is split in half on a band saw when it comes out of the die. The two halves are placed over a finished part and checked for accuracy and relationship, after which they are fastened together by bands or solder so that the template may be fitted over other parts.

(*Turn to page* 340)



The last article of the series in which the author concludes his discussion of beam and urges a new approach to the problems of designing and building

THE FUTURE OF WATER-BASED PLANES VI

waterplanes equal in performance to landplanes. He maintains that such results are inevitable; their achievement first in the United States is essential to maintenance of a leading place in aeronautical development.

By CAPT. FRANK T. COURTNEY

PROBABLY THE MOST prominent fact that comes out of an open minded study of the hydrodynamics of modern hulls is that beam has been allowed to become the primary factor in hydrodynamic study instead of being, as it should be, a secondary factor with planing area as the primary factor. As a result we have run into a state of affairs where airplane hydrodynamics have taken on an air of immense complication and difficulty when, in fact, hydroplaning is a matter of extreme simplicity, at least as compared with aero-planing.

In hydroplaning we have one surface only—the lower surface—to consider. This surface must be longitudinally flat, or at least so near to being flat that we have only a small range of curvatures to worry about. There are no problems of section, camber or circulation. The only basic variables are those of plan form, trim-angle and depth, and the practical range of these is relatively small. There will, of course, always be minor and subsidiary complications but, in general, it would seem that a quite small range of tests would give us all the basic hydroplaning data we should ever need.

The cause of the present situation appears to be that we have inadvertently allowed our hydrodynamics to be gov-

erned by our hydrostatics and hence by the transition stage—known as the "hump"—from static buoyancy to hydroplaning support. This, in fact, might have seemed inevitable since how are we going to reach the hydroplaning stage if we are not floating properly to start with?

However, the fact is that our hull dimensions are based on our flotation requirements and not our flight requirements, and the net result is that we have a beam which is far greater than our flying requirements can stand and which leads to our step, afterbody, deadrise and problems of stability, and to conditions of initial trim which largely provide our unpleasant hump curve.

I can see no reason why a new line of thought cannot be successfully adopted: one whereby the dimensions of our hull are based, as in a landplane, on flight requirements. Our hydroplaning area will then be the result of the length and breadth available, and the chances are that there will be plenty to play with. Then let us add buoyancy which, since it must add to dimensions, must obviously be retractable. This must involve problems of mechanism and weight which are likely to be much smaller than those which have been overcome in retractable land gears. It will also involve certain water drag problems in which I see nothing insuperable.

There is nothing very startling about such a proposal; it merely suggests dealing separately with our flight and our flotation requirements. However, it would naturally be subjected to all the suspicions attaching to new schemes. For that reason, as I have said, I do not propose to put forward specific methods of achieving those results until at least elementary test data are available on which arguments can be based.

Aerodynamics of Hulls

It is possible to imagine, or even to produce, a hull of conventional streamline form in which the bottom unfolds to provide the hydroplaning characteristics needed, but it is hardly likely to be a practical proposition. It seems at present that our hull is likely, in any case, to have to fly with the flat, or nearly flat, hydroplaning surface with its discontinuities—such as chines in some form—which water performance demands. Hence, as I said earlier, the waterplane *may* inevitably pay some such aerodynamic penalty for use of the water, a penalty to be compensated by land gear weight saving.

When you look at the beautiful streamline shape of the modern landplane airliner you might suppose that a hull which cannot employ such a "perfect streamline" must necessarily lose considerably. Actually this "perfect streamline" is largely an illusion. It would be what it appears to be if, like a dirigible, it had no wings. But the wings produce a curved airstream which rises well ahead of them and falls well behind. So your streamline isn't what it seems.

In military aircraft such matters as gun turrets, radio gear, and assorted hatch requirements provide turbulence which sadly disturb any attempt at perfect fuselage streamlining. This is presumably why the drag *coefficients* of some modern boat hulls compare not too unfavorably with those of corresponding landplane fuselages.

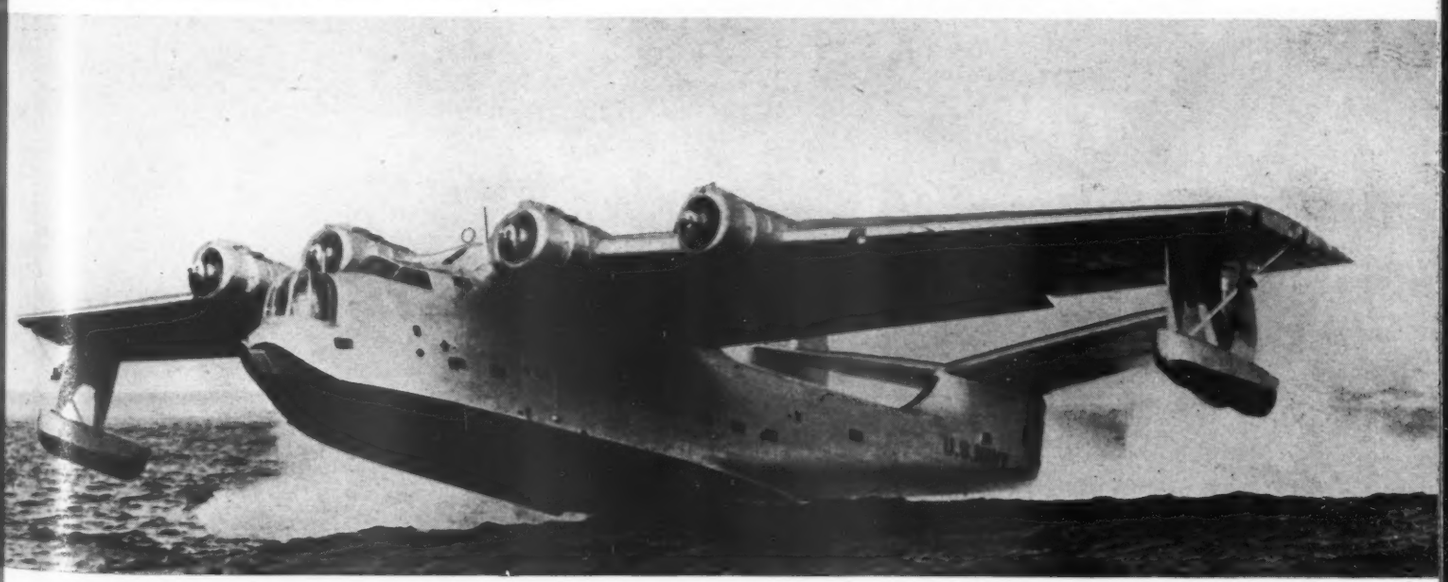
Another factor is the fact that drag is affected not only by an excrescence in itself but also by its location. For example, rivet heads on the forward section of a wing cause more loss than similar rivet heads located further aft, partly because the local air speed around the forward rivet heads is greater and partly because the turbulence they cause is spread backwards over the wing. Thus the drag of steps and chines—or anything which may take their places in future hydrodynamic development—must be considered with respect to their location as well as to their dimensions and form, and an excrescence above the wing is likely to provide higher drag than a similar one below the wing. So wind-tunnel tests of body shapes without wings are not likely to be very decisive.

For those reasons I believe that the drag of future hull forms will be somewhat above that of landplane fuselages but not very much so, since the main hydrodynamic disturbances to air flow will be considerably less than they are now and will be low and aft. For those reasons also I believe, as previously mentioned, that the smallest sizes, such as single seat fighters, will present the greatest difficulty in these respects since, in general, their bodies are so small that hydrodynamic provisions are likely to be proportionally large and scale effect may be adverse.

(*Turn to page* 284)

LEFT: Water-based planes can have hulls of excellent aerodynamic shape even though that form does not conform to generally accepted conception of the "perfect streamline" which many landplanes now appear to have, the author maintains, pointing out that further study along this line is essential to progress in waterplane design.

BELOW: The study of handling planes on the water embraces three subjects: pilot technique; stability and control of the ship; and actual forces of the water, separated into vertical and horizontal components, Capt. Courtney declares. Length of waves is as important as height, but as yet has been given little study.



SAE HOLDS AIRCRAFT PRODUCTION MEETING

FIG. 1. More than 1,600 members of the SAE, aircraft industry sections, registered for the Oct. 1, 2, and 3 meeting in the Biltmore Hotel, Los Angeles. In this photo Col. J. H. Jouett (back to camera), president of the Aeronautical Chamber of Commerce of America, has just joined the lineup at the registration desk.

FIG. 2. The Aeronautics Division of the SAE Standards Committee has breakfast before it gets down to work. Reading from l. to r., those present were: Harold Adams, Douglas Aircraft Co., Inc.; J. D. Redding, SAE staff representative; B. C. Boulton, Lockheed Aircraft Corp.; Arthur Nutt, Wright Aeronautical Corp.; C. E. Stryker, War Production Board; L. D. Bonham, Lockheed Aircraft Corp.; and John A. C. Warner, general manager of SAE.

FIG. 3. President A. W. Herrington (right) and Mac Short, Vega Aircraft Corp., snapped just after President Herrington had announced that Mr. Short is the choice of the Nominating Committee for next president of SAE, and had called the nominee to the platform to be introduced to the huge Friday night general meeting audience.

FIG. 4. Headliners on the program for the general session, Oct. 2, snapped in an informal conference just before the meeting was called to order by Chairman A. T. Colwell, reading from l. to r. are: Tye M. Lett, Jr., Allison Division, General Motors, with the AVG in China; Col. J. H. Jouett, Aeronautical Chamber of Commerce; Chairman Colwell; President A. W. Herrington, Mac Short, Vega Aircraft Corp.; and Thomas Wolfe, Western Air Lines, representing the Air Transport Association of America. Their speeches refuted current criticism of United States military aircraft.

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FIG. 5. The Adel Precision Products Corp. booth was built by two Adel employees in their spare time. Visitors could raise and lower the model plane's landing gear by manipulating the Adel controls it demonstrated. Other products of the company were on view at right and left.

FIG. 6. A "prospect" for membership in the SAE listens to E. F. Lowe of the society's Los Angeles office, as he discusses advantages and qualifications. Background of the SAE booth is liberally decorated with literature and photos.

National Aircraft Production Meeting of the Society of Automotive Engineers, meeting in Los Angeles October 1-3, draws 1,600 engineers for technical sessions. Jouett, Herrington assert U. S. planes superior.

HOW TO MAKE 1943 United States aircraft better and manufacture them quicker was the principal theme of the National Aircraft Production Meeting in Los Angeles, Oct. 1, 2, and 3. Conducted by the Society of Automotive Engineers, the three-day meeting was the largest since Pearl Harbor, devoted to technical matters, and was attended by more than 1,600 members of the SAE.

Although currently under fire as inferior to English, German and Japanese planes, United States aircraft were declared to be equal to, and in many instances superior to those of the enemy nations. Figures on combat success ratios were repeatedly quoted to prove the superiority of both United States airmen and their equipment. Thirteen papers and four speeches were delivered during the eight conference sessions of the meeting, all directly or indirectly proving present excellence and providing information upon which to increase it in the months ahead.

High point of the meeting was the general session, held on Friday night, Oct. 2. A record-breaking audience heard President A. W. Herrington of the SAE, President J. H. Jouett of the Aeronautical Chamber of Commerce of America, Thomas Wolfe, of Western Air Lines, Inc., representing the Air Transport Association of America, and Tye M. Lett, Jr., Allison Division of General Motors and recently on the AVG in China ground crew staff, report on the fighting excellence of United States aircraft and personnel.

A. T. Colwell, vice-president of Thompson Aircraft Products Co., and chairman, opened the meeting with a short statement of all four of the scheduled speeches. It was that United States airmen are the best in the world; the aircraft with which they are equipped excel those of the enemy; that quality is being steadily improved; production is meeting its goals; and the latest models are arriving in such quantities, at fronts all over the world, they have already tipped the balance of air power to the Allied Nations' side on all but two fronts, Iceland and Russia.

Col. Jouett deplored the current wave of criticism of United States aircraft as unfounded in fact and detrimental to public morale. He quoted "box scores" of air engagements which he said proved the excellence of both United States airmen and their planes, and commended the SAE for the standardization program it has carried on for many years. Standardization, he pointed out, has made possible the quick servicing and repair that is keeping United States military aircraft in a high state of efficiency.

President Herrington of SAE, in his address, enlarged upon the same theme and urged his audience to read and preserve the editorial in the September issue of AVIATION (pages 89 and 90).

"My old boyhood chum," Herrington said, "James H. McGraw, Jr., president of the McGraw-Hill Publishing Company, has set down your 'box score' in permanent form in a recent editorial which appeared in AVIATION. As most of you are familiar with the contents of your own trade papers I will not take the time to repeat it here. It is a grand and fitting salute to a job well done and should be in your company's files for future reference."

Proof that much criticized but actually superior United States aircraft will be far better and manufactured in Axis-staggering quantities in the months ahead was evidenced by the subjects covered in the technical papers given during the meeting. As is the custom at SAE meetings of this type, sessions were

devoted to such subjects as Aircraft Engines, Flight Testing, Airframes Production Technique, Aircraft Welding, and Aircraft Materials. Papers were about problems connected with these session titles.

Although restricted by the limitations imposed by military secrecy, all but two of the originally scheduled papers were presented. These two, one on Automatic Engine Power Controls and one on Flash Welding-Aircraft Quality, were cancelled at the request of the federal government. No discussions were permitted after the reading of papers, also at the request of the military, to prevent unintentional leaks of vital information. Instead of the discussions, which were cancelled after the program had been announced, the time allotted to them was used to present industrial movie films supplied by the Wright Aeronautical Corp., Bell Aircraft Corp., and the Hamilton Standard Propeller Division of United Aircraft Corp.

The 13 papers and 4 speeches fell into four categories: i.e.—Research reports, properties of new materials, improved methods and processes, and data concerning existing aircraft and engines. Three of the four speeches refuted the current attacks upon United States aircraft with data of an over-all nature. The fourth, by Mr. Lett, was a more or less detailed "report from the front" that bore out the contentions of the other three speakers, and did it with specific instance citations. Mr. Lett touched on the "Flying Tigers" fighting record only as background for the main portion of his talk, which was devoted to the problems encountered and solved by the AVG ground crews.

Three technical papers were devoted to research matters. Three others covered the topical subject of new materials. And four papers provided information on new methods and new processes. Through the latter ran the "build them quicker" theme, and through the materials group it was "licking the materials shortages" that was emphasized.

Research information was provided on Principles of Pressure Cooling in a paper prepared by J. E. Ellor of the British Air Commission and read at the opening session by Chairman R. N. Du Bois. The data was drawn from studies by the British aircraft industry, and indicated that most of the problems connected with this necessity of military planes have been licked.

Additional data was added to the general fund being accumulated by the industry's engineers, when Wayne D. Cannon, Wright Aeronautical Corp., presented the paper he prepared on Requirements for Carburetor Air Filters for Aircraft Engines. After reviewing the history of such filters, and emphasizing that in-the-field is not the place to manufacture or install them, he stated that the problem of installation design is properly the responsibility of the aircraft manufacturer.

Intercoolers and Their Performance in Aircraft was another fast trip into the realm of data about militarily necessary, but as yet not completely proven, equipment. The paper, prepared by P. A. Scherer and S. K. Anderson of AiResearch Manufacturing Co., and delivered by the former, compared the intercooler to the "Old Woman Who Lived in a Shoe," with so many parameters engineers do not yet know exactly what to do. Because there are gaps in the engineering knowledge about intercooler problems, and altitude is one product on which no ceiling will be clamped by government, the paper predicted much additional research. The discoveries, however, will be concealed because of military secrecy. At present, under pressure of the demands of war, design is only a pace ahead of production. The gap will widen as the fruits of this new research become available.

Grouped by the nature of their contents, the three papers devoted to new materials, one delivered Friday and the other two at the closing session on Saturday morning, disseminated information that is currently sought throughout the aircraft industry. One discussed the problems involved in substituting less-critical for critical materials, and the other two gave detailed accounts of aircraft uses so far developed for two prominent wood-plastics.

In his paper on Non-Critical Materials for Airframes Production, L. D. Bonham, of Lockheed Aircraft Corp., cautioned that a better title would use Less-Critical in place of Non-Critical because practically all materials used in aircraft are more or less critical. His use of the word critical differed from what is meant in its military uses, he explained. He did not advocate adoption of any single substitute, but instead discussed the problems involved in using steel, wood and plywood, insulating material substitutes, and plastics; rubber elimination and substitutes for commonly used plating and finishing materials. He concluded by stating that aircraft engineers must realize their responsibility in this crisis and that the sum total of the savings they effect will pay huge dividends by its contribution to the war effort.

Wood-Plastics in Mass Production of Aircraft, a paper prepared by Curtiss L. Bates and Harold J. Black, both formerly of the Plxweve Manufacturing Co., and delivered by Mr. Bates, reviewed the history of use of wood in aircraft and discussed new uses made possible by development of new materials and new methods.

The paper called attention to neglect of the technique of aircraft woodworking from 1930 to 1940, except in some small plane plants, and to the magic and sudden appearance of so many self-styled aircraft woodworking experts. It pointed out that there is a difference between producing wood parts for 100 airplanes and producing the same parts

FIG. 7. Magnetoes were the chief product displayed by the American Bosch Corp. in its streamlined booth . . . FIG. 8. A single-row, nine-cylinder member of a famous family is displayed in the Wright Aeronautical Corp. booth with a simplicity of surroundings that emphasized the clean lines of the engine . . . FIG. 9. Interstate Aircraft and Engineering Corp. displayed samples of 50-calibre machine guns, a bomb, hydraulic cylinders, bomb release mechanisms and other parts in its display booth.

for 10,000 airplanes. To produce in large quantities it is just as important to have proper tooling for wood as it is for metal. It is just as important to have good production designs; just as important to have ample and satisfactory production planning. Unfortunately, he said, the ease with which wood can be worked is too often confused with a license to work it carelessly.

The paper's conclusion was that wood is a satisfactory aircraft material when suitably reinforced by plastic substances; recent techniques for handling it seem to indicate its place is now permanent in aircraft; and that wood plastics should be looked upon as a fundamental structural material rather than as a second-best substitute.

C. R. Mahaney of the Panelyte Division, St. Regis Paper Co., delivered the closing paper of the convention. Its title was New Applications of Panelyte in the Aircraft Industry. It listed use of Panelyte as flooring, skin, panels, stabilizers, doors, fairings, furniture, pulleys, tanks, housings, baffles and fabricated parts. It concluded with the prediction that this material, which has been accepted as a substitute, will become a permanent material for certain uses in the manufacture of aircraft.

Six papers covered new methods and processes. One by W. T. Dickinson of Douglas Aircraft Co., Inc., described equipment, largely developed by that company, for recording flight test data automatically. It concluded with the prediction of greater instrument accuracy, more durability and reliability of measuring machines, and increased recording speeds, and that with these advances will come advances in the aeronautical arts.

Technical Developments in High Production Sheet Metal Forming, a paper prepared by W. Schroeder and T. H. Hazlett of the Lockheed Aircraft Corp., was delivered by Mr. Schroeder. Impact Extrusions and Cold Pressing of Aluminum Alloy Airplane Parts was a report of work done in that field at Consolidated Aircraft Corp., and discussed by Phil Koenig of that company.

How Vultee Uses Master Layout for Production, by S. R. Carpenter, Vultee Field Division of Vultee Aircraft, Inc., described that plant's method of producing complete and accurately scaled, full size drawings on metal sheet showing all information required for jigging and tooling of assemblies. Emphasis was on those shortcuts by which this widely used method has been speeded up. Savings in time were conservatively estimated at: 30 percent for the template department; 5 percent in the plaster shop; 15 percent in the jig department; and 20 percent in tool design.

G. S. Mikhalapov of the National Research Council read a paper on The Place and Uses of Spot Welding in Design and Production of Aircraft, and Template Duplication by Dry Offset Printing was covered in a paper prepared by W. A. Collins and J. T. Barnes of the Curtiss-Wright Corp., and read by R. C. Blaylock of that company.

Second largest audience of the three-day meeting gathered for the Monday night session at which W. G. Ovens of the Wright Aeronautical Corp., read his paper titled Some Notes on Design Features of the Mitsubishi *Kinsei* Engine. (See AVIATION, July, 1942, page 110.) Illustrated with photograph slides, the paper covered a study of all intact portions of an engine from a Jap plane shot down by Allied airmen. The paper made comparisons with United States practices and standards, and suggested probable reasons for peculiarities the study had uncovered. It called the engine a very good, but not exceptional, powerplant copied in large part from proven features of established engines.

An annual feature of the aircraft production meetings which this year attracted more than the usual attention was the Aircraft Engineering Display, arranged by Chairman J. H. Kindelberger and his committee. Displayed in 26 booths were the newest products of 23 of the industry's suppliers. They included: Aeroquip Corp., Swedlow Aeroplastics Corp., American Bosch Corp., Parker Appliance Co., Ducommun Metals & Supply Co., Rohm & Haas Co., Tinnerman Products, Inc., Interstate Aircraft & Engineering Co., and Simmonds Aerocessories, Inc.

Wright Aeronautical Corp., Cleveland Pneumatic Tool Co., Ryan Aeronautical Co., Kelite Products, Inc., International Nickel Co., Magnaflux Corp., Lord Manufacturing Co., Pacific Airmax Corp., Oakite Products, Inc., Adel Precision Products Corp., Harrison Radiator Corp., Turco Products, Inc., National Screw & Manufacturing Co., and Purolator Products, Inc.

Sponsors of the meeting were the SAE and its four Pacific Coast sections, with the cooperation of the Aeronautical Chamber of Commerce of America, Inc., and the Air Transport Association of America.

A. E. Raymond, Douglas Aircraft Co., Inc., was the general chairman. On SAE President Herrington's staff were Peter Altman, Vultee Aircraft, Inc., the SAE Aircraft vice-president; and C. F. Bachle, Continental Aviation & Engineering Corp., the SAE Aircraft Engine vice-president. Home office SAE representatives were John A. C. Warner, general manager, C. B. Whittelsey and Joseph Redding. The Pacific Coast sections were officially represented by Foster M. Gruber, Douglas Aircraft Co., Inc., chairman, and George Tharratt, Adel Precision Products Corp., vice-chairman of the southern California section; F. W. Twining, Twining Laboratories, chairman of the northern California section; J. R. Kessler, Oregon Parts Co., chairman of the Oregon section; and Kenneth A. Ayers, Standard Oil Co. of California, Seattle, chairman of the Northwest section.

FIG. 10. Ryan Aeronautical Co. demonstrated features of exhaust manifolds it manufactures . . . FIG. 11. The booth of Tinnerman Products, Inc., displayed many items of that firm's line, including speed nuts, clamps, clips, assembly rings, pulleys, and brackets of many types and sizes . . . FIG. 12. A plastic nose section and other plastic parts surrounded by unusual lighting and a mirror-like base that created a double exposure effect, presented the Swedlow aeroplastics line of aircraft components.

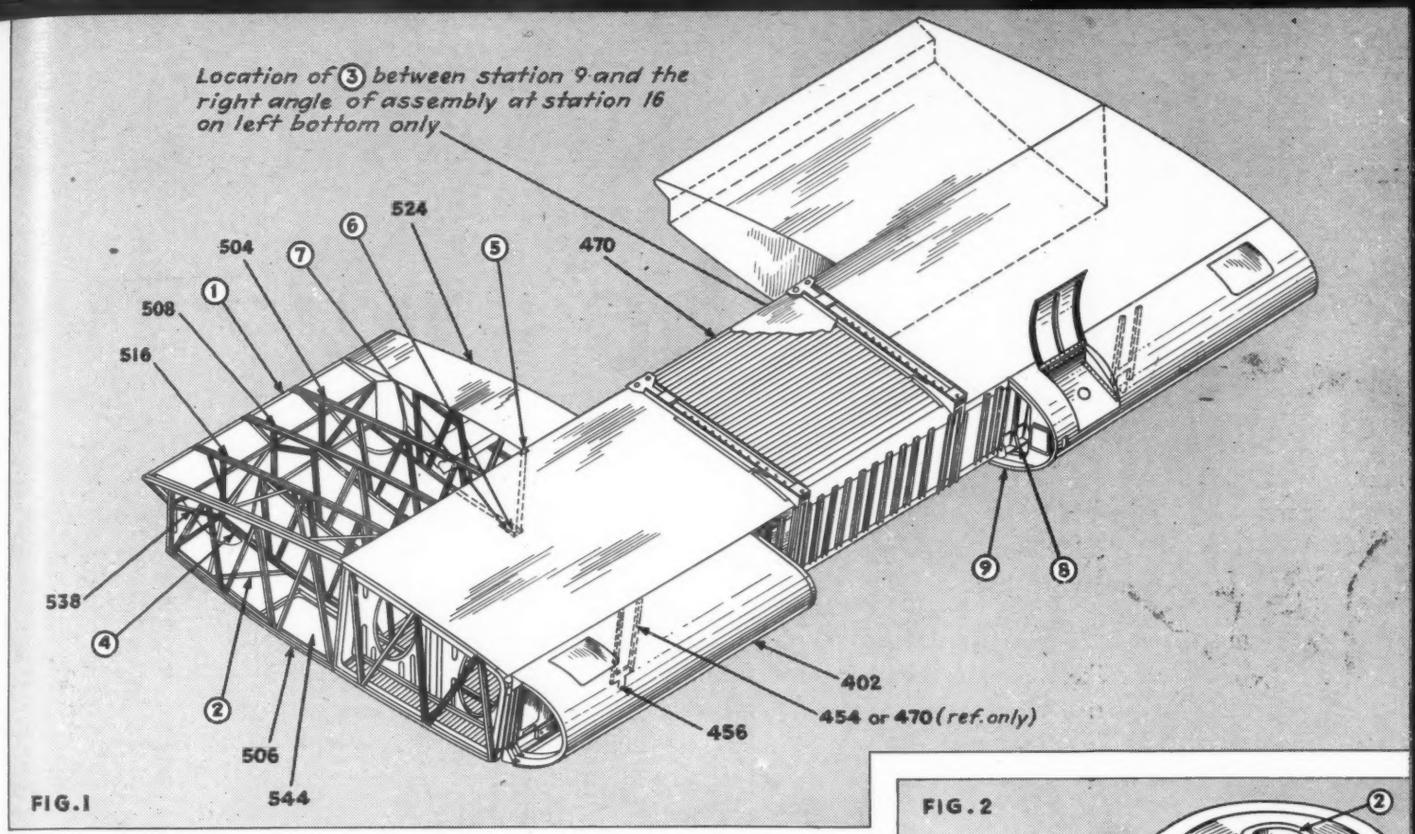
Cutting through "Atlantic soup"

DURING the past year, 995 out of every 1,000 American-built bombers and flying boats have ferried the Atlantic safely—a loss rate of only one-half of one per cent!

This remarkable performance record has been achieved in spite of the treacherous storms and heavy fogs of the North Atlantic that make instrument flying a common necessity.

Every day our ferry crews are placing their confidence in Kollsman Precision Instruments, for thousands of those planes are Kollsman-equipped to a high degree.

We're proud of the part Kollsman instruments play helping them cut through "Atlantic soup."



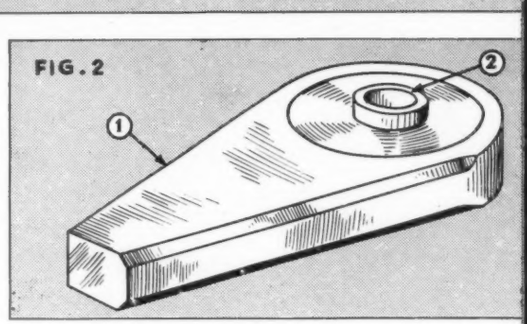


FIG. 1. Isometric drawings, prepared as one of the many functions of Fleetwings' tool engineering department, have proved highly effective in aiding new workers through assembly stages. Typical is the wing-section assembly shown in Fig. 1. The circled numbers list the parts required, the other numbers the parts to be assembled. An accompanying sheet lists the assembly procedure to be followed, in this case the work being simplified so that only 15 steps are required. FIG. 2. Even simple assemblies have their isometric drawings and assembly procedure instructions, as shown in Fig. 2. Here the drawing, the parts required and the assembly procedure can all be put on one sheet.

Tool Design Gains Importance

Necessity for increased use of semi-skilled labor puts added burden on tools and jigs; swift production essential to maintain steady output of finished parts.

By JOHN J. SCHEPPE
Chief Tool Engineer, Fleetwings, Inc.

THE WORK of the tool designer seems to increase at a faster rate even than that of aircraft production. This is due in part to the fact that new and unskilled workers are constantly being brought into the field—their lack of skill must, as much as possible, be made up by tools. It is also due in part to the fact that designs, even on parts of aircraft, are seldom frozen for any length of time.

Since, in the vast majority of cases, speed is vital in getting the tools into the hands of workers, tool design and production must be organized as well as the parts and aircraft assembly lines themselves. Thus, in the case of a concern doing both prime and subcontracting work, changes are so many and frequent that this work assumes major importance, even though it may not appear so spectacular as engineering crack pursuits or giant bombers.

At Fleetwings, for example, the tool engineering department has nine different sections, each with well designed lines of operation.

Following the release of blueprints by the Production Engineering Division the first step in tooling up to build an aircraft surface, for instance, is initiated by the tool planning department. Here the tool planning board, collaborating with a process engineer and representatives of both tool design and jig design departments, make a careful study of each of the blueprints. This phase of the program is known as the breakdown, since each of the many parts will be listed in sub-assemblies, and all the tools necessary to fabricate the parts are recorded. The importance of this step cannot be over-emphasized, since it is obvious that the speed with which production can be moved along depends largely upon the efficiency of the tooling and the ease with which parts can be assembled.

As the tool engineers record the various tools and jigs which will be required, the process engineer outlines the actual methods of fabrication selected

(*Turn to page* 280)

Maybe he's *your* boy

IT seems only yesterday he was a gawky schoolboy, all hands and feet and tousled hair.

Even then you worried a little, parent-like, about how fast he drove his battered jollopy.

Now he's flying—or soon will be—the deadliest weapon in the air, a sleek 400-mile-per-hour fighter.

Or perhaps his battle station is the bombardier's "barber chair," or the tail-gunner's "goldfish bowl" in a giant bomber, or at the controls of a U-boat-hunting blimp.

Whatever his duty, more than your fears and your prayers fly with him—all your hopes, all your dreams for him and for your country ride in that aircraft, too.

What cost of effort or zeal or self-denial is too great—if it will give him the finest plane, the safest equipment in the air?

We feel the same way about it here at Goodyear Aircraft. Many of our men and women have sons, or brothers, or husbands, in the air forces, too.

And beyond this there is the sober knowledge, clear now to all Americans, that our cherished liberty, our standard of living cannot be secure again until this nation wins command of the air—and it is these boys who must win it for us.

It is for them, your lad and ours, that Goodyear aircrafters—welders and riveters, pressmen and foremen, engineers and executives together—are striving with all the skill and ingenuity of long aeronautical experience to help build the safest, sturdiest airplanes and airships modern engineering can create.

It is to give them mastery of the skies that we are working in round-the-clock shifts, seven days a week, to produce our full share of the airplane subassemblies—wings, tails, control surfaces, cabin units, wheels, brakes and other parts—for the 60,000 airplanes America must have this year.

In this we are working with and for the manufacturers of some of America's most famous battleplanes, both fighters and bombers, that are proving their superiority on all fronts.

If your boy is flying one of them, you can be sure his craft is as staunch and airworthy as scores of great American industries cooperating together can make it.

For these boys, yours and ours, are the hope of America, the guardians of the greatest heritage ever given to any people. They will not fail us, nor we them.

AMERICA MUST BE FIRST IN THE AIR

Unless and until America is the most powerful nation in the air, our safety, our freedom, and our standard of living will not again be what they have been in the past.

P. Litchfield

GOODYEAR

AIRCRAFT

HOW GOODYEAR AIRCRAFT CORPORATION SERVES THE AIRPLANE INDUSTRY
1. By building parts to manufacturers' specifications.
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4. By extending our research facilities to aid the solution of any design or construction problem.

To answer the widespread, increasing demand for faster-driving Phillips Recessed Head Screws, 19 prominent screw manufacturers offer their tremendous manufacturing capacity and nationwide distribution to assure prompt delivery.

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While simply changing from slotted to Phillips Screws has often speeded assembly 50%, many firms have obtained maximum results with the help of sales engineers specializing in Phillips products. Their experience is at your service — to save man-hours — to speed job-training programs — to step up production by permitting power driving, eliminating refinishing costs, fumbled and lost screws, damaging burrs.

"Remember—it's not the price of the screws that counts . . . it's the cost of using them."

Speed product deliveries by saving assembly time

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PHILLIPS RECESSED HEAD SCREWS

WOOD SCREWS • MACHINE SCREWS • SHEET METAL SCREWS • STOVE BOLTS
SPECIAL THREAD-CUTTING SCREWS • SCREWS WITH LOCK WASHERS

19 SOURCES OF SUPPLY

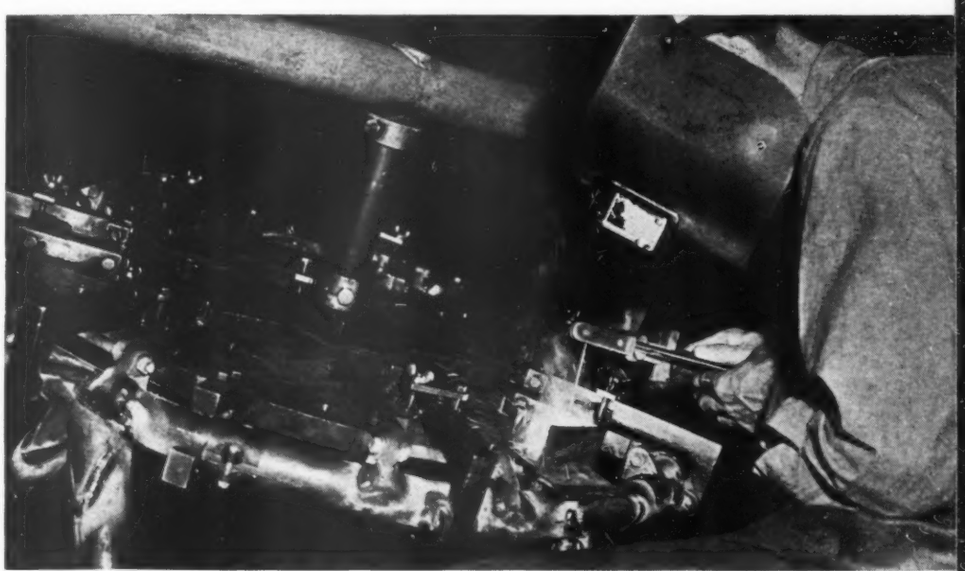
American Screw Co., Providence, R. I.
The Bristol Co., Waterbury, Conn.
Central Screw Co., Chicago, Ill.
Chandler Products Corp., Cleveland, Ohio
Continental Screw Co., New Bedford, Mass.
The Corbin Screw Corp., New Britain, Conn.
International Screw Co., Detroit, Mich.
The Lamson & Sessions Co., Cleveland, Ohio
The National Screw & Mfg. Co., Cleveland, Ohio
New England Screw Co., Keene, N.H.
The Charles Parker Co., Meriden, Conn.
Parker-Kalon Corp., New York, N.Y.
Pawtucket Screw Co., Pawtucket, R.I.
Pheoll Manufacturing Co., Chicago, Ill.
Russell, Burdsall & Ward Bolt & Nut Co., Port Chester, N.Y.
Scovill Manufacturing Co., Waterbury, Conn.
Shakeproof Inc., Chicago, Ill.
The Southington Hardware Mfg. Co., Southington, Conn.
Whitney Screw Corp., Nashua, N.H.

Factory Maintenance

This is a "how-to-do-it" article covering preventive maintenance and inspection, routine servicing, and repair of arc welding equipment. It is "must" reading for factory superintendents.

Maintaining Arc Welders For Peak Production

By R. F. WYER, *Welding Engineer, General Electric Company*



WHILE ARC WELDING SETS today represent the highest in simplicity and reliability, they will require periodic attention from a maintenance standpoint if they are to be kept in the best operating condition.

With the accent on production in aircraft plants, shipyards, ordnance plants, and welding shops of all types, the failure of even a few sets is sometimes costly. A systematized maintenance program will pay dividends in terms of better welder performance and longer life.

Selection

The right welding set must be selected for the job, because a maintenance program will be discouragingly difficult if misfit equipment is being used.

To insure proper choice of the rating of a single-operator set, the maximum current, load voltage, and duty factor (ratio of arc time to total time) must be taken into account. Except in the smallest sizes, most sets are rated on a 1-hr. load. Their rating is the current which they will deliver for 1-hr. without interruption, without exceeding a prescribed temperature rise.

Since this method of rating, chosen as a simple standard for comparison, does not take into account actual operating conditions, it is not always economically sound to choose the size next larger than the maximum operating current contemplated. However, for this same reason duty factor should be taken into account when new equipment is being considered to make certain that the set is big enough for the job.

Installation

Proper installation can do much to keep the welding equipment at work and troubles to a minimum. In wiring up a welding set, care should be taken to provide adequate branch circuit conductors, and fuse clips large enough to accommodate the necessary fuses. It should be observed that motor-generator type welding equipments have full-voltage motor starters almost without exception, so that due consideration must be given to the starting current of the motors.

Care should be taken to ground the frames of all welding equipments in order to avoid shock or annoying tickles when a grounded person touches the frame of the equipment. Even with equipment in perfect operating condition, under some conditions it is possible to receive a harmless but irritating sensation of shock from ungrounded equipment due to the passage of infinitesimal capacity or leakage currents. In addition to protecting against this annoyance, aequate grounding of machine frames is also a desirable safety precaution against harm resulting from insulation failure in equipment or leads, or improper connections.

Regardless of the type of safety ground connection which is installed, adequate low resistance work leads should always be used, and care should be taken to secure good connection between the work lead and the work. If this is not done, it is possible under some circumstances to overheat the safety ground connection by the passage of welding current through it.

In the location of welding equipment, ventilation is a very important consideration. The life of electrical insulation is seriously shortened by overheating, and overheating is bound to result where insufficient ventilation is provided. Particularly where large numbers of welding equipments are to be located in small enclosures, considerable study should be given to the problem of supplying clean, cool ventilating air. Where small houses or temporary sheds are located in hot sunshine, the heat absorbed from the sun added to the heat dissipated by the welding equipments may raise the ambient temperature above 100 F. and cause severe overheating. In such cases, large louvres or other ventilating openings should be provided in the building not only at the bottom but near the roof to give good air circulation and keep the ambient temperature below 100 F. In some instances, it is desirable to provide fans to assist in removing heated air from the upper part of such enclosures.

FIG. 1. Hand operated grease guns should always be used on pressure-relief lubricated bearings. Grease should be added slowly to permit excess to vent from relief pipe or plug . . . FIG. 2. Sanding brushes to a good fit with the commutator is essential whenever new brushes are installed . . . FIG. 3. The megger is a convenient means of determining the condition of the insulation by indicating its resistance to leakage currents . . . FIG. 4. Blowing dust out of the welder should be done carefully with low pressure air to avoid driving abrasive dust into the insulation.

Inspection

The competent maintenance man will have a record of all welders under his care. One of the most useful and easy-to-handle references is a card file. All repair work, with its cost, can be entered on the record, and any welder requiring excessive attention or expense can be investigated and causes determined and corrected.

Inspection records will also serve as a guide to tell when welders should be replaced because of the high cost to keep them in operating condition. Misapplications, abuses, and the like will also be disclosed.

A systematic and periodic inspection of motors and generators is necessary to insure best operation. While some welders are installed where conditions are ideal—where dust, dirt, and moisture are not present to an appreciable degree—most machines are located where some sort of dirt accumulates on the windings. This lowers insulation resistance and cuts down creepage distances.

Steel-mill dusts are usually highly conducive, if not abrasive, and lessen creepage distances. Other dusts are highly abrasive and actually cut the insulation in being carried through by the ventilating air. Fine cast-iron dust quickly penetrates most insulating materials.

Hence the desirability of inspecting motors periodically. If conditions are extremely severe, weekly inspection and partial cleaning are desirable. Most motors require a complete overhauling and thorough cleaning about once a year.

For the weekly cleaning, the motor and generator should be blown out with dry compressed air (about 25 to 30 lb. per sq. in. in pressure). Where conducting and abrasive dusts are present, even lower pressure may be necessary, and suction is to be preferred, as damage can easily be caused by blowing the dust and metal chips into the insulation. On most motors the windings are fairly accessible, however, and the air can be properly directed to prevent such damage.

About once a year, welders should be overhauled. First, the heavy dirt and grease should be removed with a heavy, stiff brush, wooden or fiber scrapers, and cloths. Rifle-cleaning bristle brushes can be used in air ducts. Dry dust and dirt can be blown off, using dry compressed air at moderate pressure. Care must be taken to direct the air so that the dust will not cause damage and will not be pocketed in the various corners. Grease, oil, and sticky dirt are easily removed by applying cleaning liquids such as carbon tetrachloride.

If the welder can be spared from service long enough, the insulation of the motor should be dried out by heating to from 90 to 100 C. While the motor is still warm, a high-grade insulating varnish should be applied.

The varnish may be sprayed or brushed on. After applying the varnish, the best results are obtained by

baking for 6 to 7 hr. at about 100 C. If the machine must be put back into service quickly, or if facilities are not available for baking, fairly good results will be obtained by applying one of the varnishes which dry in a few hours at ordinary room temperatures.

Lubrication

Manufacturers' instructions regarding lubrication of bearings should be carefully noted. These instructions should be kept near the welder so that they are readily accessible. Usually grease-packed bearings have sufficient lubricant when shipped from the factory to last about a year under normal conditions of cleanliness and temperature. When sets are operated in unusually dirty atmospheres, run continuously 24 hr. per day, or exposed to extremes of temperature, it would be well to shorten the bearing inspection and lubrication interval down to six months, or less if experience warrants. An occasional check of bearing temperature by feeling with the hand may disclose undue heating before damage is actually done. Once a lubricating routine has been established, it should be carried out, and by reliable men who will follow instructions.

It is pretty generally established that outside of gross neglect for long periods of time, the major causes of bearing troubles are overgreasing and dirt. Overgreasing results in excessive heating of the bearing, frequently with churning and breaking down of the grease with consequent loss of its protective qualities.

Dirt occasionally gets into a bearing through the use of grease that is carried around or stored in uncovered containers. Quite as frequently it gets in through carelessness in protecting parts while bearings are disassembled or opened for inspection.

The prevention is obvious but often overlooked:

1. Every part of a bearing assembly, including retainer plates, gaskets, and screws, should be placed in a clean box immediately on removal, and if dropped or otherwise soiled, should not be replaced without a thorough cleaning in a suitable solvent.
2. None but clean hands, tools, and rags should ever be allowed to touch a bearing.
3. Grease *must* be clean. If there is the slightest doubt of its purity, it should be thrown away. Grease is cheap compared with bearings and lost man-hours.

Only a high grade of grease should be used for ball bearing lubrication.

Brushes

Brush inspection is important. The first essential requirement for the satisfactory operation of brushes is the free movement of the brushes in their holders. Uniform brush pressure also is necessary to assure equal current distribution. Adjustment of brush holders should be set so that the face of the holder is approximately $\frac{1}{8}$ in. up from the commutator; any distance greater than $\frac{1}{8}$ in. may cause brushes to wedge, resulting in chattering and excessive sparking.

It is essential that the correct grade of brush for a specific application be used. Recommendations as to the correct grade of brush should be obtained from the manufacturer of the welder only.

Broken brushes imply two possibilities: incorrect brush grade, or mechanical defects (such as unbalanced, rough, or eccentric commutator). To eliminate brush breakage, both factors should be corrected.

Check the brushes to make sure that they will not wear down too far before the next inspection. Keep extra sets of brushes available so that replacement can be made when needed. It is false economy to use brushes down to the absolute minimum length before replacement. Cases have been known where brushes have worn down until the metal, where the pigtail connects to the brush, was touching the commutator. This, of course, was causing damage to the commutator.

Make sure that each brush surface, in contact with the commutator, has the polished finish that indicates good contact, and that the polish covers all of the surface of the brush. When replacing a brush be sure to put it in the same brush holder and in its original position. It has been found helpful to scratch a mark on one side of the brush when removing it, so that it will be replaced properly.

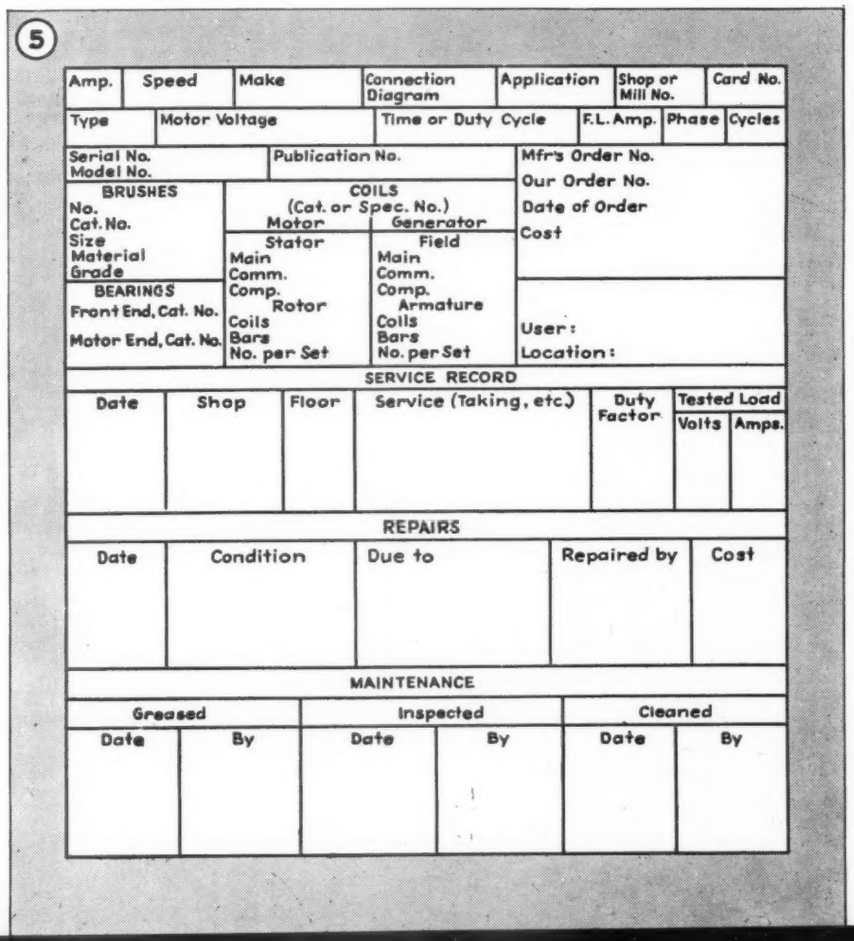
When installing new brushes, fit them carefully to the commutator. Sand only until the curve of the brushes is the same as that of the commutator. Be sure that the brush shunts (pigtails) are fastened securely so that current will not overheat the brushes and brush holders.

Check the springs that hold the brushes against the commutator. Improper spring pressure may lead to commutator wear and excessive sparking. Excessive heating may have annealed the springs, in which case they should be replaced and the cause of heating corrected.

Commutators

Inspect the commutator for color and condition. It should be clean, smooth, and glossy, with a color varying from straw to chocolate brown where the brushes ride on it. A bluish or reddish color indicates overheating of the commutator. Roughness of the commuta-

FIG. 5. Card records on every welder in the plant save time and money. Recordings made after inspection and service reflect potential major trouble that can be corrected before it occurs.



5

Amp.	Speed	Make	Connection Diagram	Application	Shop or Mill No.	Card No.
Type	Motor Voltage		Time or Duty Cycle		F.L. Amp. Phase	Cycles

Serial No. / Model No. — Publication No. — Mfr's Order No. / Our Order No. / Date of Order / Cost

BRUSHES: No. / Cat. No. / Size / Material / Grade

BEARINGS: Front End, Cat. No. / Motor End, Cat. No.

COILS (Cat. or Spec. No.)

Motor		Generator	
Stator		Field	
Main		Main	
Comm.		Comm.	
Comp.		Comp.	
Rotor		Armature	
Coils		Coils	
Bars		Bars	
No. per Set		No. per Set	

User: / Location:

SERVICE RECORD

Date	Shop	Floor	Service (Taking, etc.)	Duty Factor	Tested Load Volts	Tested Load Amps.

REPAIRS

Date	Condition	Due to	Repaired by	Cost

MAINTENANCE

Greased		Inspected		Cleaned	
Date	By	Date	By	Date	By

ARC-WELDER TROUBLE SHOOTING CHART

TROUBLE	*CAUSES*	*WHAT TO DO*
Machine fails to hold heat	Rough or dirty commutator	Commutator should be trued or cleaned
	Brushes may be worn down to limit of adjustment or life	Replace or readjust brushes
	Brush springs may have lost adjustment or may be broken	Replace or readjust brush springs
	Field circuit may have variable resistance connection or intermittent open circuit	Check field current with ammeter to discover varying current. This applies to both the main generator and exciter if used.
	Electrode lead or work lead connections may be poor	Tighten all connections
	Wrong grade of brushes may have been installed on generators	Check with manufacturer's recommendations
	Field rheostat or tap switches may be making poor contact and overheating	Inspect rheostat and clean and adjust finger tension on switches
	Brush-shifting or other mechanical current-adjusting mechanism may have loose or worn links	Check current-adjusting mechanism for back-lash and play
Motor trips off line	Power circuit may be single-phased	Check for one blown fuse or dead line
	Welder may be operating above current capacity	Check load against welder nameplate Check duty cycle
	Welding electrode or work leads may be too long or too small in cross section	Check terminal voltage while machine is loaded; it should not exceed 30 v. on small machines or 40 v. on large machines when operating at rated curren:
	Ambient temperature may be too high	Make sure that temperature in motor-generator room or housing does not exceed 100 F. and that there is no interference with normal ventilation of the machine
Machine fails to start	Power circuit may be completely dead	Look for open disconnect switch, fuses removed from clips, or blown fuses
	Power circuit may be single-phased	Look for one blown fuse or one dead line
	Power line voltage may not be suitable for motor, or may be extremely low; may be accompanied by chattering of the motor starter	Check voltage with voltmeter, particularly at the moment of attempted starting
	Machine may be jammed	See that armature turns over easily by hand, and look for foreign material in air gaps
	Motor starter may be single-phased	Check to see that all fingers on starter make contact when closed
	Overload protecting relays may be tripped	See that relay contacts are closed and that starter picks up when push button is pressed. Be sure to remove cause of tripping
Welder starts but fails to generate	May be running the wrong way	Check direction of rotation with manufacturer's instructions or direction arrow. On three-phase motors, direction of rotation may be changed by interchanging any-two leads
	Generator or exciter brushes may be loose or missing	Be sure that all brushes bear on the commutator and have proper spring tension
	Exciter may not be operating	Check exciter output voltage with voltmeter or lamp
	Field circuit of generator or exciter may be open	Check for open circuits in rheostat, field leads, and field coils. Also check resistors and rectifiers, if any. Some machines give low output when fields are open
	Generator may be reversed in polarity due to another machine or incorrect operation in parallel with another machine	*Flash the field with a storage battery or another generator first with one polarity and then with the other to see if it builds up (Flash exciter field if set has separate exciter)
	Series field and armature circuit may be open-circuited	Check circuit with ringer or voltmeter
Welding arc is loud and spatters excessively	Current setting may be too high	Check setting and current output with ammeter
	Polarity may be wrong	Check polarity Try reversing polarity or try an electrode of the opposite polarity

* " Flashing " the field of a generator or exciter is a method of establishing the residual magnetism of the field structure with the proper polarity to cause the machine to " build-up," or generate voltage. It consists of passing a relatively heavy current through the field windings momentarily, using an external source of direct current to supply the power.

If a low-voltage source, such as a storage battery, is used, the series field of the generator should be flashed; if a higher voltage source such as another generator or exciter is used, the shunt field should be flashed.

tor should be removed by sandpapering or stoning. Never use emery cloth or an emery stone. Use a "fine" stone or number 00 sandpaper unless the commutator is in bad condition, when the job may be started with a "coarse" stone and finished with "fine."

For this operation, press the stone or sandpaper against the commutator with moderate pressure with the motor running, and move it back and forth across the commutator surface. Use care not to come in contact with live parts. Keep the dust out of the machine.

If the commutator is very rough as evidenced by pronounced up and down vibration of the brushes, the armature should be taken out and the commutator turned down in a lathe. When this is done, it is usually necessary also to cut back the insulation between the commutator bars slightly. If the commutator is found to be dirty when the generator is inspected, it should be wiped clean with a piece of canvas or other cloth that is free from lint.

Never put oil on the commutator. Proper selection of brushes gives the commutator all the lubrication required to prevent excessive wear and to build up a good smooth-operating glazed surface on the copper. The addition of oil results in the development of a high resistance film which may cause undue heating and rough brush action. The oil will also have a detrimental effect on the internal parts of the commutator.

Transformers

The arc welding transformers of a.c. welders require a minimum of maintenance, but this fact should not be allowed to result in neglect. On fan-cooled units, fans should be cleaned and lubricated about once a year. Windings should be blown out at least twice a year in very clean locations, and more often in dusty places. At the time of this periodic attention, all connections and coil supports should be checked for tightness. Manual current adjusting mechanisms should be lubricated often enough to prevent stiff operation of the handwheel or crank, making sure that a fairly high melting-point grease is uniformly distributed over the full length of screws and guides. On motor-operated controls, lubrication at more frequent intervals may be required, as evidenced by slowing down of the motor or noise from the gearing. This point should be checked at least three times a year, and more often if experience justifies it.

Abuses

While most welding equipment is designed to stand up under unusually adverse operating conditions, some not

(*Turn to page* 328)

10-MINUTE ASSEMBLY JOB CUT TO 2½ MINUTES

This 20-ton Denison horizontal press is doing in 2½ minutes a job that formerly required ten . . . the assembly and disassembly of airplane engine crankshafts.

War-rushed plants all over the country are getting help like this from Denison HydrOILics. And this application is only one example of the wide flexibility and ever increasing range of oil hydraulics. In this case, it eliminates tedious, painstaking hand effort and saves valuable time and labor.

The crankshaft is locked in the fixture in three sections, with the center section held rigidly in place and the two end sections remaining movable. Operation of the selector valve directs the hydraulic fluid to either the right or left hand ram. Movement of the ram-operating lever moves the sliding section of the fixture, and assembles the splined external and internal parts of the shaft. The operator then shifts the selector valve, applying pressure to the opposite ram and repeating the operation on the other end of the crankshaft.

This is oil hydraulics at its best . . . speeding war production of critical parts. In almost every industry, Denison HydrOILics is stepping up efficiency, saving materials, eliminating operations, doing jobs faster and better at lower cost.

To find out where Denison HydrOILics can help you, call your Denison representative or write directly to the factory. The Denison Engineering Company, 1166 Dublin Road, Columbus, Ohio.

SPECIFICATIONS

Maximum Stroke, each cylinder	4"
Maximum lateral opening	25"
Size of machined bolster	22"x44"
Depth of throat from center of rams	7" ± .005
Cylinder diameter	6"
Ram diameter	3"
Floor space	28"x93"

Helpful Literature!

A 28-page catalog illustrating Denison standard and special HydrOILic presses and their applications to production problems. Catalog contains a special 12-page section of valuable engineering data and tables. Write for your copy today! On your business letterhead, please.

DENISON EQUIPMENT in APPLIED *HydrOILics*

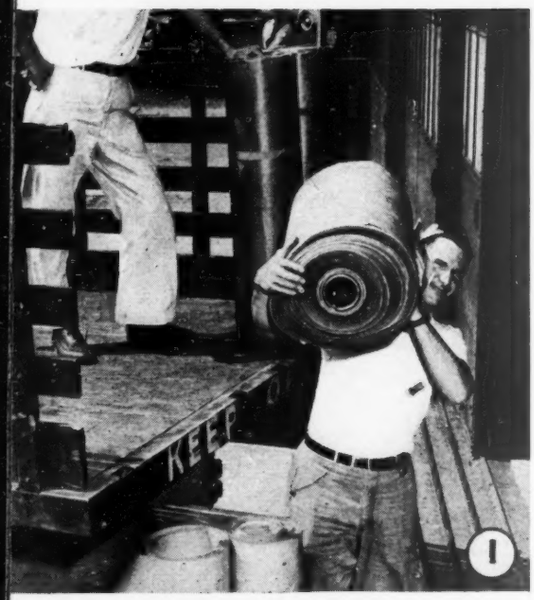
Fabricating Plane Parts From PAPER

Saving of heavy machines as well as strategic materials found possible by plastic bonded paper said to give smoother surfaces.

MANY of the secondary and some primary aircraft structures can now be successfully fabricated by use of laminated paper plastic instead of the conventional aluminum. The phenol-formaldehyde impregnated paper used in the process is made from special pulp, a material available in almost unlimited quantities.

The McDonnell Aircraft Corporation, working in cooperation with a large plastics manufacturer, a paper manufacturing company and the Pulp and Paper Section of the Forest Products Laboratory, U. S. Department of Agriculture, has produced, for example, a paper plastic wing tip composed of but 13 parts compared to 96 parts for the same tip constructed of aluminum. Tests have shown the tip to be both stronger and lighter than its metal contemporary.

In contrast to large equipment used in most plastic work now being done in the industry, it is possible to use relatively light equipment for production with the new process, since molding is done at 250 lb. per sq. in. pressure, compared with 1,000 to 2,000 lb. normally required. Further savings have been made possible since McDonnell uses kirksite dies in place of more expensive steel dies.



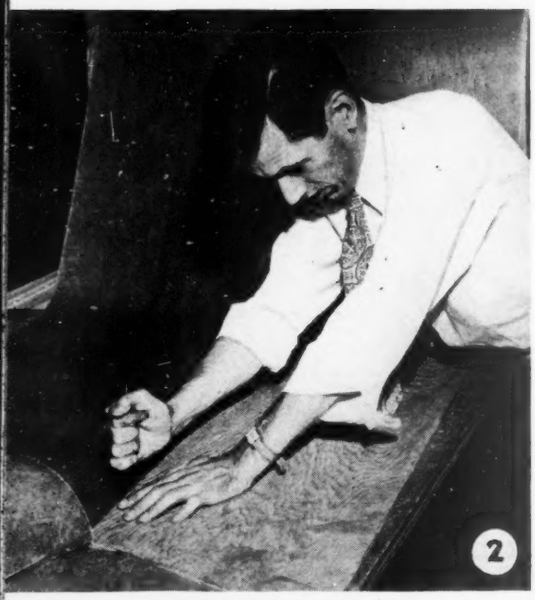


FIG. 1. Impregnated paper to be made into aircraft parts arrives at the factory in space-saving rolls. The paper is made from a special pulp available in almost limitless quantities. FIG. 2. Here the paper is cut to pattern size for an experimental wing tip. Five or six sheets of paper in this cutout form constitute the necessary thickness for forming into the tip. In a production operation, multiple cutouts would be made in a single operation by large cutting machines. FIG. 3. The wing tip skin comes from the press. Molding is done at 250 lb. pressure compared with 1,000 to 2,000 lb. pressures used in most other processes. This use of lighter equipment helps save vitally needed heavy machinery. Also, kirksite dies instead of more expensive steel dies can be used. FIG. 4. A laminated paper plastic experimental wing tip under a static load of 2,800 lb., 140 percent of design breaking load of a comparable aluminum tip. Under this load the wing tip showed slight failures but was not destroyed. FIG. 5. McDonnell Aircraft Corporation Engineers Karl Kopplin (left) builder, and Charles Marschner (right), designer, show beginning of the process in the form of impregnated paper and the end of the process in the finished wing tip. Advantages of the laminated paper plastic tip are smooth surface not involving finishing and coating required for metal and wood; greater resistance to abrasion and denting and adaptability to double curvature forms.

The B.F. Goodrich Airplane of the month

NORTH AMERICAN B-25

JAPAN WON'T FORGET its visit from the B-25's. You can be sure of that! And these fighter-fast bombers will strike again . . . wherever the Army commands. That's a promise made by the manufacturer, North American Aviation. Leading military planes are supplied with B. F. Goodrich products . . . De-Icers, so they can fight the enemy and forget the weather . . . Silvertown Tires and Expander Tube brakes for greater safety . . . and other important rubber and synthetic rubber parts. This month, B. F. Goodrich salutes North American and nominates the B-25 Bomber as Plane-of-the-Month.

In war or peace

B.F.Goodrich

FIRST IN RUBBER

B.F. GOODRICH RUBBER RESEARCH FOR THE *Aviation industry*

De-Icer slide films are valuable aids in visual training programs

TO HELP in the task of passing the "know-how" about De-Icers along to your personnel, B. F. Goodrich offers a group of four reading slide films. These four 35-mm. films, together with booklet editions of each film, are available for Army and Navy training centers, schools, airlines and aircraft manufacturers.

"The Development of the De-Icer" gives a brief explanation of: the causes and conditions of aircraft icing, what De-Icers are and how they operate. This short film shows the need for complete protection from ice.

"De-Icer Servicing and Installation" shows the various steps in removing, repairing, storing and re-installing De-Icers. Maintenance personnel will like the assistance this film gives when working on De-Icers.

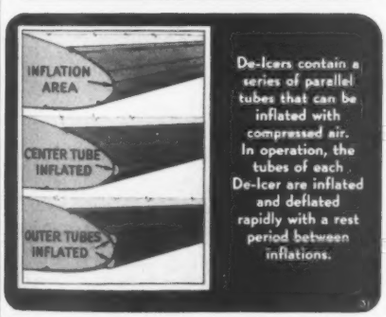
"De-Icer Operation" contains specific information for pilots, and other flight personnel on matters concerning De-Icer operation. This film is now in preparation.

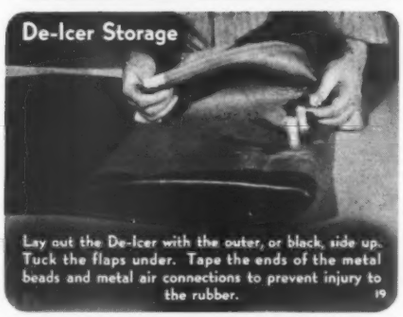
"De-Icer and Design" illustrates in detail the various types of De-Icers, methods of installation, attachment devices and the air supply system. It will assist aircraft production personnel—designers and engineers—when they incorporate B. F. Goodrich De-Icers in future planes.

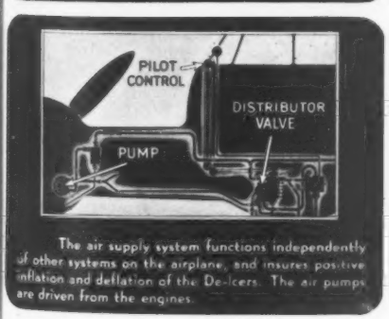
MAKERS OF B. F. GOODRICH TIRES AND OVER 80 RUBBER AND SYNTHETIC RUBBER PRODUCTS FOR AIRPLANES

THESE *Excerpts from the films* ILLUSTRATE THEIR VALUE TO AIRCRAFT PERSONNEL

What causes the formation of ice upon aircraft?
Generally, two conditions must exist —
Visible moisture, and temperatures below +34 degrees Fahrenheit.
In engine induction systems, ice may form when temperatures are as high as +70 degrees Fahrenheit.


INFLATION AREA
CENTER TUBE INFLATED
OUTER TUBES INFLATED
De-Icers contain a series of parallel tubes that can be inflated with compressed air. In operation, the tubes of each De-Icer are inflated and deflated rapidly with a rest period between inflations.


De-Icer Storage
Lay out the De-Icer with the outer, or black, side up. Tuck the flaps under. Tape the ends of the metal beads and metal air connections to prevent injury to the rubber.
19


PILOT CONTROL
DISTRIBUTOR VALVE
PUMP
The air supply system functions independently of other systems on the airplane, and insures positive inflation and deflation of the De-Icers. The air pumps are driven from the engines.

Installing New De-Icers
To prepare the airplane for new De-Icers, apply adhesive tape over all skin laps and rivet heads in the De-Icer area to prevent localized wear on the undersurface of the rubber. Around salt water use a coat of P-27 primer on the skin under the De-Icer.
28

BOOKLET RÉSUMÉS

We have prepared pocket-sized booklet editions of the slide films. The booklets contain all of the individual pictures and accompanying reading text from the films. If you are now using the films as part of a regular instruction course, you will appreciate the opportunities these pocket-size booklets afford in further establishing De-Icer principles. We suggest you distribute copies of the booklet edition of the films to members of the audience for individual study.

HOW TO ORDER

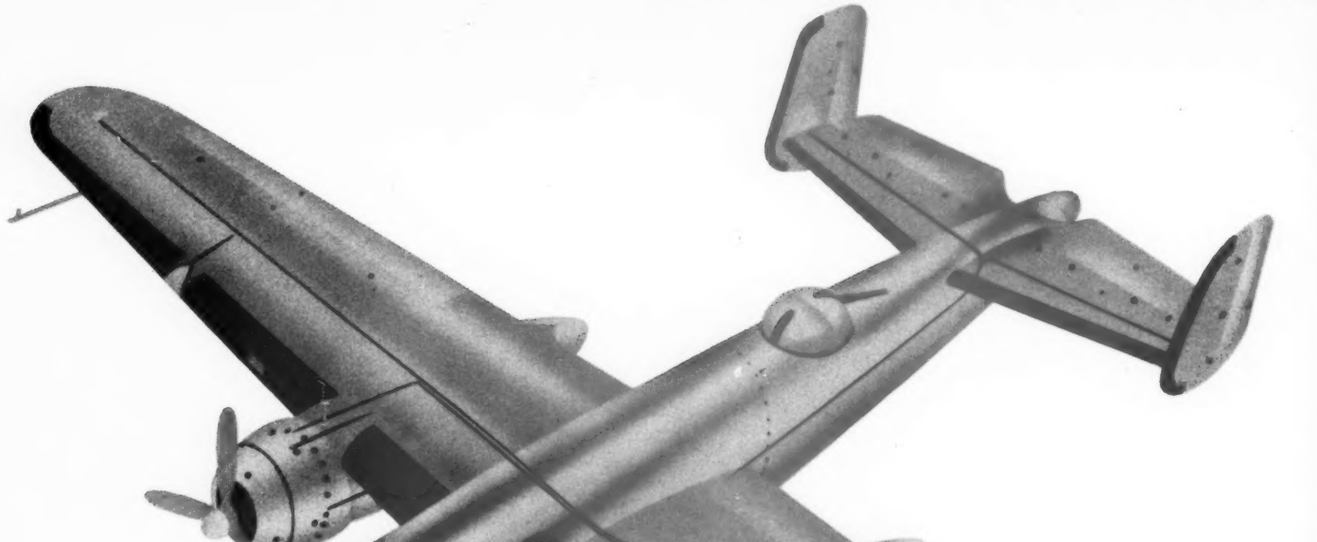
Both the films and booklets are available without cost to qualified persons in the aeronautical industry who send in their requests on a company letterhead. When requesting the films, please tell us how many copies of the booklets you can use to advantage. Write to the B. F. Goodrich Company, Department 7191, Akron, Ohio.

In war or peace

B.F.Goodrich

FIRST IN RUBBER

From the B. F. Goodrich Notebook



THIS DRAWING SHOWS where the B. F. Goodrich products are on a typical medium bomber. You will be able to distinguish everything from grommets to the De-Icers on the leading edge of the wings. In addition, bullet-sealing fuel tanks, carefully concealed for military reasons, are located in the plane.

B. F. GOODRICH SILVERTOWN TIRES help a student pilot achieve safer, smoother landings—thus building his confidence. You'll find tires bearing the famous name, Silvertown, on planes of all sizes, from primary trainers to huge 4-motor bombers, and on commercial planes and private planes as well. They help immeasurably to "Keep 'Em Flying"!

B.F.GOODRICH
General Offices
Akron, Ohio

Fabricating Plastic Dies for Acrylate Sheets

Savings in time and money possible through use of cast phenolic plastics; heat transfer qualities held superior to metal dies.

By KENTON J. LEEG, *Plastics Division, Baker Oil Tools, Inc.*

THE PROCESS OF FORMING acrylate sheets is well known, simply involving the heating of the plastic until it is pliable enough to readily form into the contours desired, holding it in position in this form, and allowing it to cool and set. There are, however, various technical problems that make the process somewhat more involved than it may appear.

The possibility of forming strain lines in the acrylate sheet, for example, is rather great, and careful control is necessary. These strain lines may appear for various reasons. Some of them come about:

1. If the acrylate sheet is not hot enough to form readily;
2. If considerably more stretching occurs in one part of the sheet than in another, without suitable gradation of this stretching effect between the two parts;
3. If the cooling of the plastic sheet is not uniform.

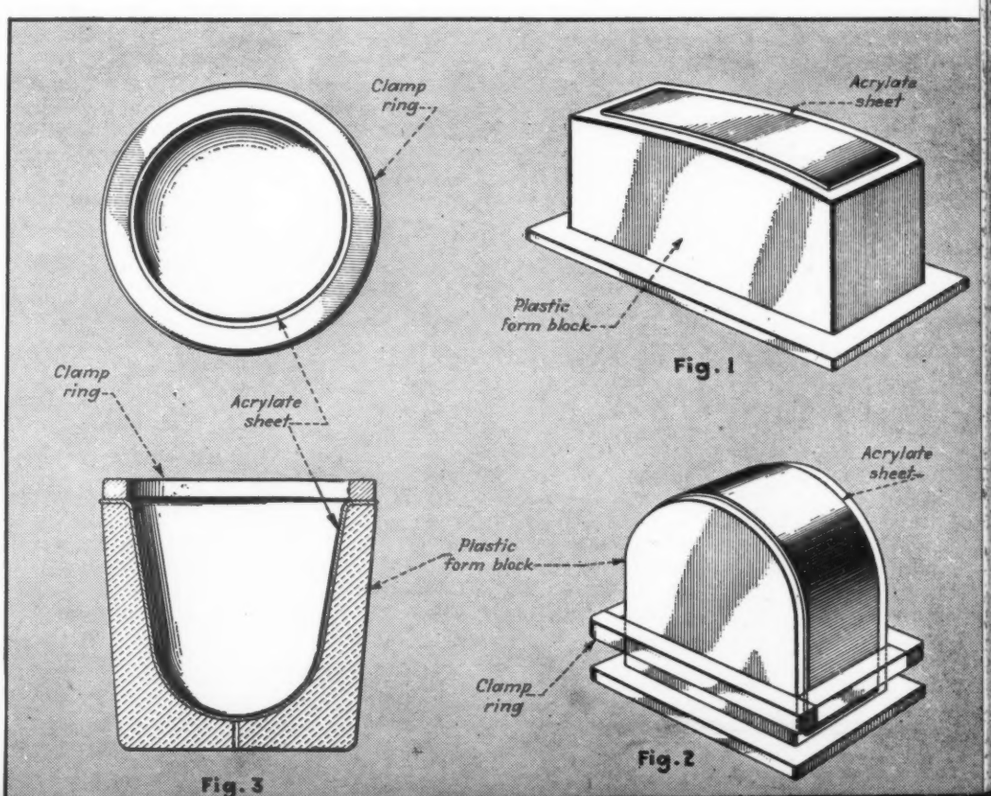
The last cause of strains is the one that can be better controlled with plastic form blocks than with most other materials. The types of form blocks must be considered in connection with this discussion.

The simplest type is the form block with only bending lines to be achieved, and with contours of such large radius that it is not even necessary to clamp the acrylate sheet in position while it is being cooled (Fig. 1). The second type is a similar die with sharper contours, requiring a clamp to hold the plastic in place during the cooling process (Fig. 2). The third type involves the use of a ring clamp around the edge of the sheet and the forming of that sheet by pressure (Fig. 3).

At the present time, these dies are made of various materials, a large part of them being of hardwood, some being made of metal, and some of plaster of paris or hydrocal. Each of these materials has its own particular advantages and disadvantages.

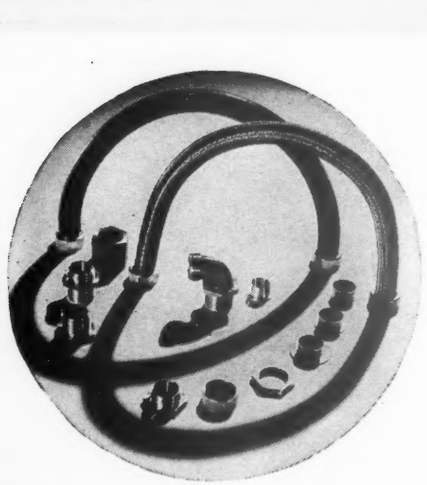
The plaster of paris dies can be made much more readily than any of the others because of the ease of forming and the ease of handling this material. It is possible to make a pattern partly of plaster and partly of modeling clay and from this to make a mold in which the plaster of paris die can be cast. This is the simplest means of obtaining the mold in some cases. In others it is easier to cast plaster of paris roughly to shape and cut it down to make the desired die. The ease of obtaining a die of this sort makes it the logical choice of materials for dies in which the plaster of paris can stand up well enough to take care of the products to be run. However, if a good many parts are to be formed on the die, the plaster of paris loses water rather rapidly and becomes chalky or cracks on the surface. Therefore, if many parts are to be made, the plaster of paris becomes more and more expensive, because of the large number of die replacements necessary to complete the run and because of time lost during replacements. The reason for this cracking in the case of plaster of paris dies is that the hardness of the plaster of paris depends on the degree of hydration of the material, and the heat absorbed from the acrylate sheet causes evaporation of the water, thereby causing the eventual breakdown of the die.

Of course the fabrication of metal dies is the slowest, in most cases, of any type of material that is used. The amount of hand work necessary to fabricate the metal die is well known and is a definite handicap to the use of metal except where a very large number of parts are to be formed. The metal die, on the other hand, is dimensionally stable and is considerably more resistant to the various forces which may cause the breakdown of the dies. In addition to the high cost of fabricating of metal dies, there is an inherent disadvantage in the use of metal for this purpose. When acrylate sheets are formed on metal dies, at the start of a run the die is cold, and, since it is a good conductor of heat, the die itself absorbs a



OFF THE PRODUCTION LINE

minutes faster!



American Flexible Low-Tension Shielded Conduit and a complete line of fittings and accessories conform to A-N, A-C and N A F specifications.

THIS production war has become one of minutes... hours have been licked. And minutes can be saved in the building of every single airplane by giving us the job of assembling your American Flexible Low-Tension Shielded Conduit and Fittings.

The same men who produce the product . . . the people who know the conduit and fittings inside out... will perform this job for you to your exact requirements.

Simply send us the complete specification. We will tell you by return mail how the assembling can be handled to *your* best advantage.

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General Offices: Waterbury, Conn. • *Subsidiary of Anaconda Copper Mining Co.*
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ANACONDA

American Metal Hose

large part of the heat from the acrylate sheet. This absorption of heat is oftentimes uneven due to variation in thickness of the metal die and causes variations in the cooling rate of the plastic, thereby developing strain lines in the formed piece. As the run progresses, the metal die increases in temperature until it comes up to approximately the temperature of the acrylate sheet as it is applied to the die. From this point on the die acts as a reservoir for the heat from the plastic, absorbing a large part of the heat immediately upon application of the plastic sheet and returning it to the plastic sheet during the cooling process, which slows the forming cycle for the material and consequently decreases production rates.

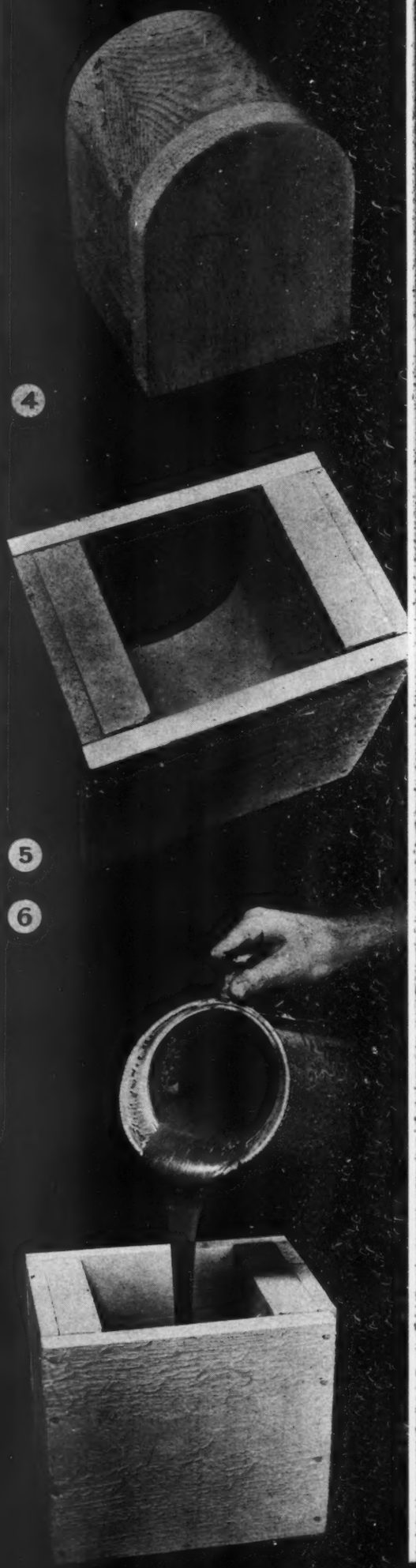
The wood die is the most satisfactory for most purposes because it has a rather low heat transfer. This allows the heat to be lost from the acrylate sheet to the air instead of to the die, and allows for consistent cooling rates whether the run is a short run or a long run on that particular die. Since the cooling rates are consistent and uniform, the plastic pieces that are formed on a wood die are much less likely to have strains developed. The main difficulty with the wood dies is caused by the fact that they are made of blocks of wood glued together. Occasionally, when the block is used in rapid production for a long run, the glue is heated to such a point that it will lift above the surface of the die and produce a thin line of material with a different coefficient of heat transfer from that of the rest of the block. This causes a variation in cooling rate in the sheet at this point, and produces strain lines in the finished product. While this can be controlled by inspecting the blocks often and avoiding formation of such glue lines, it is difficult to be sure this will always be done. In addition to this, the preparation of the wood die is largely a hand-forming operation. This means that the die is relatively expensive, and takes quite a little time to produce, which may cause a bottleneck in production.

Some recent tests have been run on the forming of acrylate sheets using Baker Cast Phenolic plastic dies. This is a liquid phenol-formaldehyde liquid resin of low viscosity that can be used in the rapid production of form blocks. It is simply poured into a mold in the liquid form and set by baking. The Baker plastic die claims the advantages of the best of the other dies and none of their disadvantages have been encountered. The original pattern of the form block can be made rapidly and easily of plaster of paris. From this pattern, a negative mold can be made again of plaster of paris and, into this mold, the liquid phenolic plastic is poured and set, and the finished die is obtained with a minimum of labor and without loss of time. The plastic form block, as produced by this method, has no irregularities in heat transfer as has the wood die, and has about the same low heat transfer as that of the wood. Consequently, the acrylate sheet that is being formed on the plastic form block does not have the danger of being formed with strain lines that is encountered in the wood die,

(*Turn to page* 336)

Cast phenolic plastics are being used for complex, as well as simple, dies for forming acrylate sheets with savings in both time and money. The process for fabricating such a die is shown here.

FIG. 4. The pattern can be inexpensively made of wood or plaster of paris. . . FIG. 5. Plaster is poured around the pattern to make a plaster mold for the plastic forming die. In some cases, the plaster mold is merely slushed into shape to avoid the use of a pattern. . . FIG. 6. The mold is lacquered, the plastic is mixed with catalyst and walnut shell flour and poured into the mold. The casting is then baked for about 2 hr. at 170 deg. F. . . . The finished plastic die is easily removed from the plaster mold and is covered with a layer of cloth. . . FIG. 8. Finished die is then ready for use in forming the acrylate sheet.



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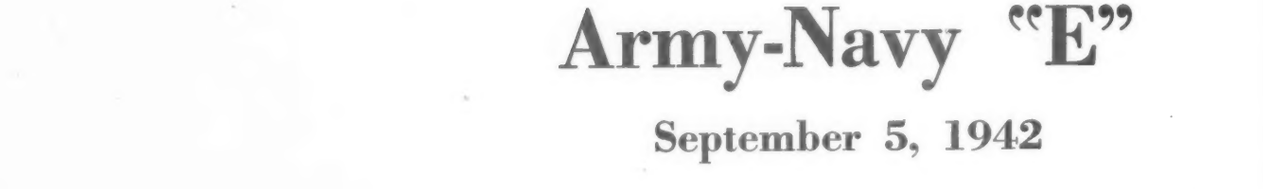


Specimens of magnesium shapes welded by the heliarc process developed by Northrop engineers. Almost any thickness of cast metal that can be poured may be readily welded by the process.

Heliarc Welding Opens New Horizons In Aircraft Design and Construction

Magnesium welded structures now feasible. Developed by Northrop engineers, the company has released detailed information for benefit of all industry.

A TYPICAL EXAMPLE of the aviation industry's all-out cooperation for victory (see page 94) was the action of Northrop Aircraft, Inc., in releasing full information on its "heliarc" welding process after two years of intensive development by Northrop engineers.

V. H. Pavlecka, chief of research, and Russ Meredith, welding engineer, together with other men of the Northrop organization, believing that vast new possibilities would be opened up in aircraft design and construction by development of a satisfactory method of welding magnesium, worked tirelessly to that end. They are confident now that their process permits the arc welding of magnesium sheets, extrusions and tubing into structures simpler, lighter, and stiffer than is possible in conventional duralumin construction. They point out, too, that methods of treating magnesium to make it less inflammable and more resistant to heat have been perfected.

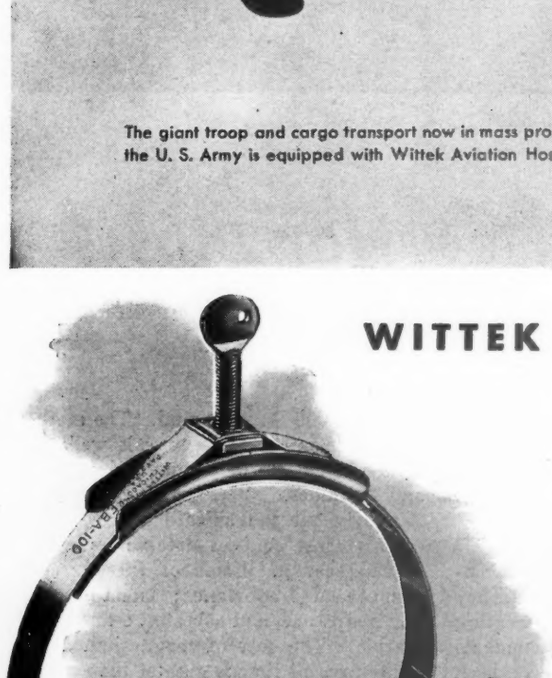
While magnesium has been used for some time in the aircraft industry for engine parts, wheels and accessories, it has not previously been used extensively as a primary construction material because of the difficulties in fabricating.

Magnesium is the most abundant metal on the earth and in the ocean. About 15 percent of all the dissolved solid matter in the sea consists of magnesium chloride and magnesium sulfate —enough to cover all the land areas of the earth to a depth of 60 or 70 ft. or 9,000,000,000 lb. per cu.mi. The mother liquors from the brine of salt wells are always rich both in magnesium salts and bromides.

Nearly all the silicate rocks of the earth's crust contain notable quantities of magnesium. Some of these are of commercial importance; examples are talc, soapstone, and asbestos, cement, and marble. The cost of magnesium alloys at the present time is greater than aluminum alloys. However, because of new magnesium plants under construction and increased production in the plants now in operation, magnesium alloys will be cheaper than aluminum alloys in a very short time. Twenty-four thousand kilowatt hours are required to produce a ton of aluminum from Bauxite and only 18,300 kwh. are required to produce a ton of magnesium, which has 54 per cent more volume. Magnesium alloy will shortly be the most plentiful alloy. The world's largest deposits of Brusite,

(*Turn to page* 323)

The giant troop and cargo transport now in mass production for the U. S. Army is equipped with Wittek Aviation Hose Clamps.



WITTEK *AVIATION* HOSE CLAMPS

For Dependable Hose Connections

Since the beginning of modern aviation Wittek has been a producer of hose clamps for that industry. From the epic days of 1924 when the U. S. Army Air Corps circled the globe in the three Douglas World Cruisers—to the present era of advanced military aircraft, Wittek has kept pace with the requirements of the industry for dependable hose clamps.

Today, Wittek Aviation Hose Clamps are known as the standard of the industry and are being used by the outstanding builders of military aircraft. Wittek Aviation Hose Clamps are made of quality materials, by experienced craftsmen and designed to meet existing Army and Navy specifications. Wittek Manufacturing Co., 4305-15 West 24th Pl., Chicago.

WITTEK *Aviation* **HOSE CLAMPS**

Flight Recorder To Ease Test Pilot's Job

The "flight recorder," an electronic instrument capable of recording temperature and pressure changes at the rate of 144 readings every few minutes, has been developed by the Brown Instrument Co., subsidiary of Minneapolis-Honeywell Regulator Co., to aid test pilots in tabulating vital data on engine and plane performance in flight. It is a portable instrument and is now being used regularly by the Army, Navy and leading plane manufacturers.

The instrument automatically records as many as 144 different readings throughout various parts of the plane and automatically prints a record on graph paper at the rate of about one reading approximately every second. As applied to the test flight of airplanes, most of the measurements are those of temperature, although the instrument is capable of recording any physical phenomena which can be transformed into a change of voltage or current.

In the development of aircraft, the device is of importance in so far as it relieves the pilot of making test readings while he is engaged simultaneously in the operation of the plane. Accordingly, with an instrument of this type installed in the plane, readings will be made regularly and automatically and the pilot may devote his entire attention to the proper manipulation of the airplane controls. Another advantage of the flight recorder is that many more readings may be obtained in a given time interval so that much more complete and detailed information of the flight is available than has heretofore been the case where readings were recorded manually.

The basic recorder, which is the result of several years of research, was in the process of development for use in industrial plants when the need arose for some new type of instrument capable of compiling test data on the Douglas B-19, the world's largest plane in flight. To meet this emergency, a corps of electronic and mechanical design engineers went to work in the Brown laboratories and adapted the experimental recorder in the process of development for the test run of the huge plane.

The requirements of the successful flight recorder have been met by the adaptation of a new type of self-balancing electronic potentiometer which completely eliminates the mechanical galvanometers which have been used extensively in industrial equipment for the measurement of temperature. As applied to the measurement of temperature, the relative temperature of any designated point on the plane or engine is determined by means of thermocouples located at the strategic points. The difference in temperature between the two ends of the thermocouple produces an electromotive force across its terminals. The voltage across a potentiometer equal to the thermocouple voltage is then selected by motordriven mechanical means. Ordinarily, the quality of voltages in the two cases is indicated by 0 current which in turn is measured by a galvanometer. In the electronic flight recorder, the galvanometer is replaced by a multi-stage amplifier which drives a motor to restore the cap on the potentiometer to the appropriate position. When the appropriate null indication is obtained, the correct relative temperature is automatically recorded on a continuous chart. This is the essential method of operation for making one temperature reading.

For making additional temperature readings, a switching arrangement is used to introduce any of the remaining thermocouples into the electrical system. The switching arrangement for selecting the appropriate thermocouple is synchronized with the recording mechanism so that when a null or balanced condition obtains for each thermocouple in the test, its appropriate temperature is automatically printed on the chart paper.

Features of particular interest in the new device are the replacement of the usual type of galvanometer by an electronic amplifier, null indicator, and motor driving system which makes it possible to use the instrument in the severe conditions of temperature, humidity, and vibration which are encountered in flying. The stability of the electronic system also gives the instrument its big advantage of making up to as many as 144 recorded readings in about 3 min. If all 144 thermocouples are employed, it is possible to get a reading of each individual thermocouple at an interval of approximately 3 min. If fewer thermocouples are used, it is of course possible to obtain readings of any one of the group in a smaller time interval. An additional feature which results from the improved design is that the instrument can measure to better than 1 deg. F., whereas temperature meters formerly used and visually observed could not be depended upon to temperatures closer than about 10 deg. F.

The flight recorder consists of two portable cases in addition to the individual thermocouples which are distributed as the test data requires throughout the plane. Two instruments are contained in boxes about the size of a small suitcase. The electronic amplifier and recorder are in one case and the synchronized switching arrangement for the 144 thermocouples in the other. The complete installation weighs 128 lb. of which 63 lb. are assigned to the recorder mechanism itself. The recorder uses 15 ft. of chart paper per hour, which is enough for a flight lasting 8 hr.

The portable "flight recorder," new instrument which obtains data on engine and plane performance in flight testing America's new fighting planes. Lieut. William C. Clay, USN, is inspecting the new instrument with E. B. Evleth, vice-president and general manager of the manufacturer, Brown Instrument Co., subsidiary of Minneapolis-Honeywell Regulator Co.

Speed Up GUN BARREL INSPECTION

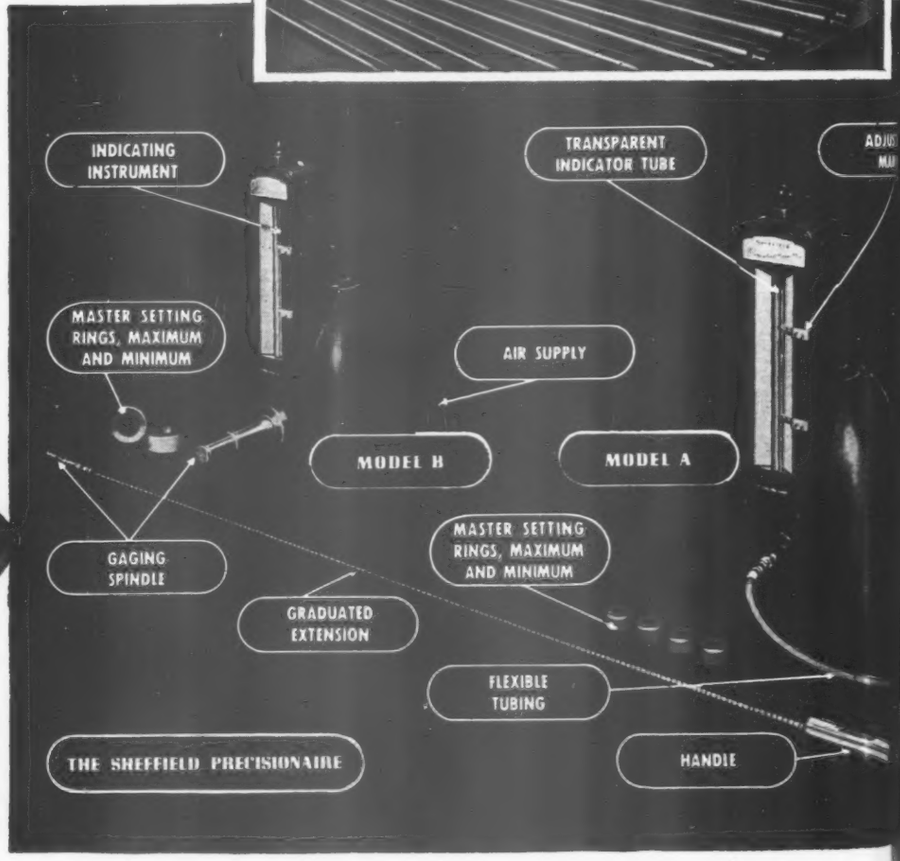
In just one pass through a gun barrel the Sheffield Precisionaire tells the inspector whether or not the bore is within prescribed tolerance or, if not, whether it is oversize, undersize, out-of-round, or bell mouth —also exactly at what point any dimensional discrepancy occurs.

It takes no longer to inspect a gun barrel than it does to push a cleaning rod through it and no more skill, in spite of the fact that the Precisionaire is accurate to .0001″. Any new operator having no previous experience can be taught to handle this gage in less than fifteen minutes.

Contrast this speed and this accuracy with inspection by previous methods which were not only slow but which required the highest order of gaging skill in order to maintain accuracy.

The same instrument provided with two slightly different gaging spindles is used to check the bore before rifling and then, by changing the spindle, give it a final inspection after it is rifled.

The Precisionaire, while it is being used extensively for gun barrel inspection, has a number of other very important uses all described in bulletin 42-23. Write for your copy now.



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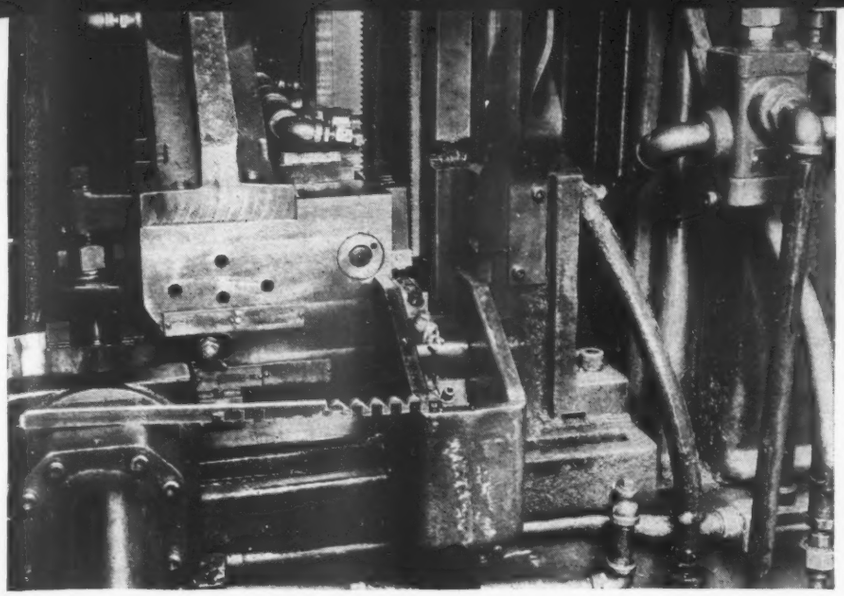


FIG. 3. This La Pointe broach was specially tooled to turn out spring pack retainers from regular extruded bar stock. It has condensed several operations into an automatic sequence. The cost of the part has been reduced 75 percent.

Shortcuts Speed Propeller Production

PRODUCTION MEN at Hamilton Standard Propeller Division of United Aircraft have exercised considerable ingenuity in getting the maximum volume and variety out of the limited machine tools available.

Engineers and tool operators continually are seeking new methods of performing complex operations on standard machines which are more easily obtainable than special machinery formerly used. Ingenious tooling and development of automatic feed mechanisms frequently eliminate the need for a skilled operator, thus releasing a trained workman for higher responsibilities or a more difficult job.

Typical of such planning was the substitution of a Morton keyseater, not in great demand, for a Pratt & Whitney vertical shaping machine with a rotary table—a machine which was difficult to obtain. (See Fig. 1.) The Morton keyseater not only was in less demand than the shaping machine, but also was smaller and, because it was a standard product on the market, was less expensive.

The operation performed by the two machines in this case was the generating of a hex into the piston which serves as a combination piston and propeller retaining nut on all controllable pitch propellers. This hex permits the use of a wrench in adjusting the part.

The Morton keyseater was converted into an automatic machine for this purpose by the construction of special fixtures. A Geneva motion with a cam arrangement was utilized, the feed mechanism being obtained from the cam and the divisions from the Geneva motion. This simplification in operation eliminated the need of a skilled operator, conserved floor space, provided an 80 percent saving in labor, and increased production 40 percent.

The smooth finish of parts under stress loads, such as the spider which positions the blades, has always been a necessity in propeller manufacture. To perform these simple polishing operations, machines and fixtures comparable to those required for the major manufacture of the parts have been required.

The arms of the spider, whether it is for a two, three or four blade propeller, are bored through the center to cut down the weight of the part and all these bores must be polished. Previously a turret lathe was used and 18 min. were required for each operation.

Production men of Hamilton Standard and Cheney Bros., designed a special eccentric polishing head (See Fig. 2), with the eccentricity obtained by the utilization of cams. Incorporation of a work holder and a feed mechanism made the machine semi-automatic and a special bob was designed to form the radii at the bottom of the arm bore.

The operator now places the work in the holding fixture, starts the machine, and actuates the eccentric spindle to a stop which performs the required operation. Then the work is indexed and the same procedure followed for a second time. The entire operation of polishing the arm bore and its radii is now performed in less than one-third of the time required with a turret lathe.

Hydromatic propellers require a large quantity of spring pack retainers, 16 being provided for each blade. These small U-shaped parts hold the springs which provide the drive between gear segment and propeller blade for changing the pitch of the propellers. They are in effect the shock absorbers for this drive mechanism.

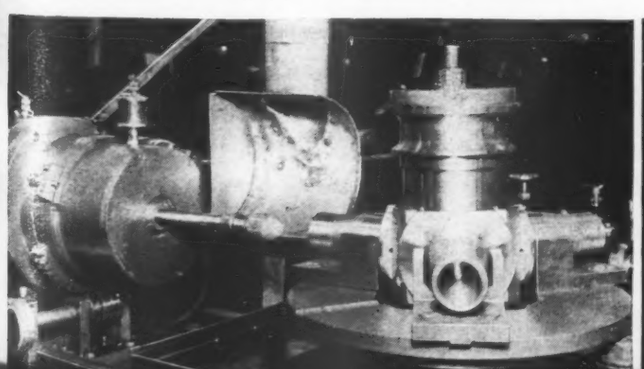
Originally a specially formed extruded bar stock was used. This was first milled out through the center, broached, and then parted to the proper size. It was then necessary to grind the outer surfaces of the retainers to the proper close tolerance.

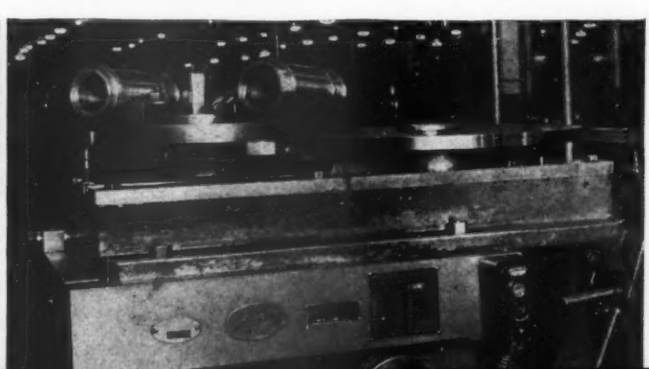
In an effort to cut down the time required to make these small parts and also to reduce the cost, Hamilton Standard production men studied ways and means of providing an automatic machine.

A self-fed LaPointe broach was used. Careful analysis of the job enabled the substitution of standard rectangular bar stock for the special formed bar stock. Not only did this accomplish a saving in cost of raw material, but it also eliminated the problem of obtaining special stock.

(*Turn to page* 320)

LEFT: FIG. 1. Morton keyseater, through use of special fixtures, is converted into an automatic machine at Hamilton Standard Propeller Division of United Aircraft Corp., with a saving of 80 percent in labor on the operation and an increase of 40 percent in production of the part. . . . RIGHT: FIG. 2. An eccentric polishing head for polishing spider arm bores completes its operation in less than six min. Previously a turret lathe was used and required over three times as long to complete the same operation.





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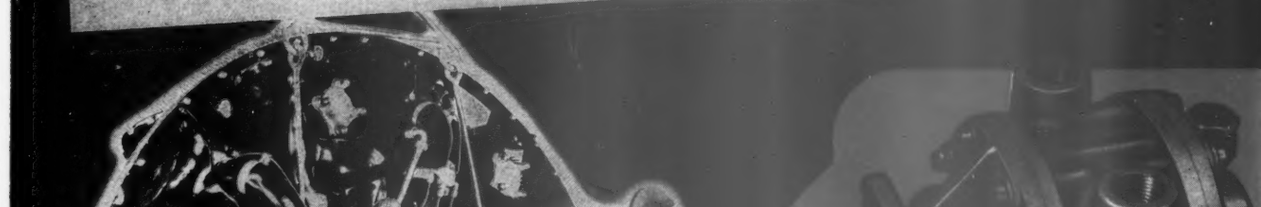

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REVIEW OF PATENTS

By A. HARRY CROWELL, *Registered Patent Lawyer*

THE FOLLOWING are digests of the more significant of recent patents on aviation developments announced by the U. S. Patent Office. Mr. Crowell will be glad to furnish AVIATION readers with preliminary information entirely without charge respecting their patent and trademark matters. Address inquiries to Mr. Crowell, in care of AVIATION, 330 W. 42nd St., New York. Complete printed copies of any of the patents listed are obtainable at a cost of 10c. each directly from the U. S. Patent Office at Washington.

Airfoil Lift Coefficient Varying Means, 2,292,360. E. R. Brewster. A method of increasing the lift coefficient of the wings of an airplane in which the trailing edge of the wing or airfoil is split. A hinged flap, like the usual braking is provided, so that the propeller creates a strong suction behind this flap when it is open to permit reduced landing speeds.

Portable Aircraft Catapult, 2,292,374. P. G. Hagenbuch. For use in restricted areas. The construction includes one or more track frames mounted on a truck or trailer body and having suitable guy wires and jacks, together with an airplane carriage mounted on the track.

Safety Belt, 2,292,386. F. G. Manson. A shoulder-type quick detachable safety strap fastened at the top center of the chair frame with the ends connected at the forward sides of the chair frame to slidable pins. The pins can be simultaneously withdrawn to release the strap.

Safety Device for Use on Aircraft Employing Retractible Landing Gears, 2,292,392. G. Miller. A power circuit closed by operation of the landing lighting switch to remind the pilot that his landing gears should be operated.

Aircraft Landing System, 2,294,882, A. Alford, assignor to International Telephone & Radio Manufacturing Corporation. The invention consists in a radio guiding means for directing the landing of aircraft and consists especially in an aircraft glide path having a radiation pattern of a hyperbolic or other shape, that allows the location of radiating antenna remote from a landing runway.

Retractable Loading Gear for Airplanes and the Like, 2,294,918, R. L. Levy, assignor to Societe d'Inventions Aeronautiques et Mecaniques, SIAM. A device in which the lifting of the landing gear causes the retraction of the shock absorber, and, consequently, a reduction in the length of the under-carriage in the retracted position as compared to the extended position, and particularly applicable to oleo-pneumatic suspension devices of the so-called "two liquid" type.

Directional Instrument, 2,294,990, P. Kollsman, assignor to Square D Company. A magnetic compass which can be rigidly mounted on a fixed part of the craft similar to other control instruments and which will not be affected by oscillatory vibrations, the dial being fixed in a substantially vertical position and the conventional gimbal mounting being eliminated.

Airplane Control Balancing System, 2,295,159, E. R. Child, assignor to Curtiss-Wright Corporation. Consists of elastic devices acting upon the control stick or rudder pedals of an aircraft, the devices having no effect when the stick or pedals are in a neutral position, but having an increasing effect tending to displace the control stick or pedals after they have once been moved in any direction from the neutral position. Counter-balances the aerodynamic forces tending to return control surfaces to a neutral position after control function displacement.

Airplane Cockpit Enclosure, 2,295,345, J. R. Jerman, assignor to Vultee Aircraft, Inc. The movable section or hatch has the rollers and trackways so mounted and formed as to be enclosed and free from ice formation or aerodynamic drag.

Propeller Blade, 2,295,454, P. D. Cesare, assignor to Di Cesare Offset Propeller Corp. The blade is formed completely of wood laminations impregnated and compressed to form a compact unit. Separate strips are glued on for ultimately forming the shank.

Unilaterally Supported Resilient Wheel Mounting for Aircraft Undercarriages, 2,296,017, R. H. Bound and G. H. Dowty, assignors to Dowty Equipment Ltd. A unit designed for standardization and quantity production embodying an adjustment means for taking care of widely different load and structural conditions.

Aircraft With Sustaining Rotors, 2,296,250-1, J. A. J. Bennett, assignor to Autogiro Company of America. A mechanism for controlling the pitch angles of the rotor blades of a rotaplane or helicopter. It controls the craft in flight and can be used to obtain increased pitch angle when applied torque increases as in the case of a helicopter. In a rotaplane it may be used to obtain the necessary conditions for a jump start.

Controllable-Pitch Propeller, 2,296,288, E. Martin and J. E. Anderson, assignors to United Aircraft Corp. The propeller has a range of speed regulating, pitch changing movements beyond the speed regulating range in which the propeller is brought into and out of a feathered condition.

(*Turn to page* 324)

Wright Uses Plastic Engine Parts To Save Aluminum

Two engine parts, previously fabricated of sheet aluminum, are now being made of plastics by the Wright Aeronautical Corp., makers of Wright *Cyclone* and *Whirlwind* aircooled plane engines.

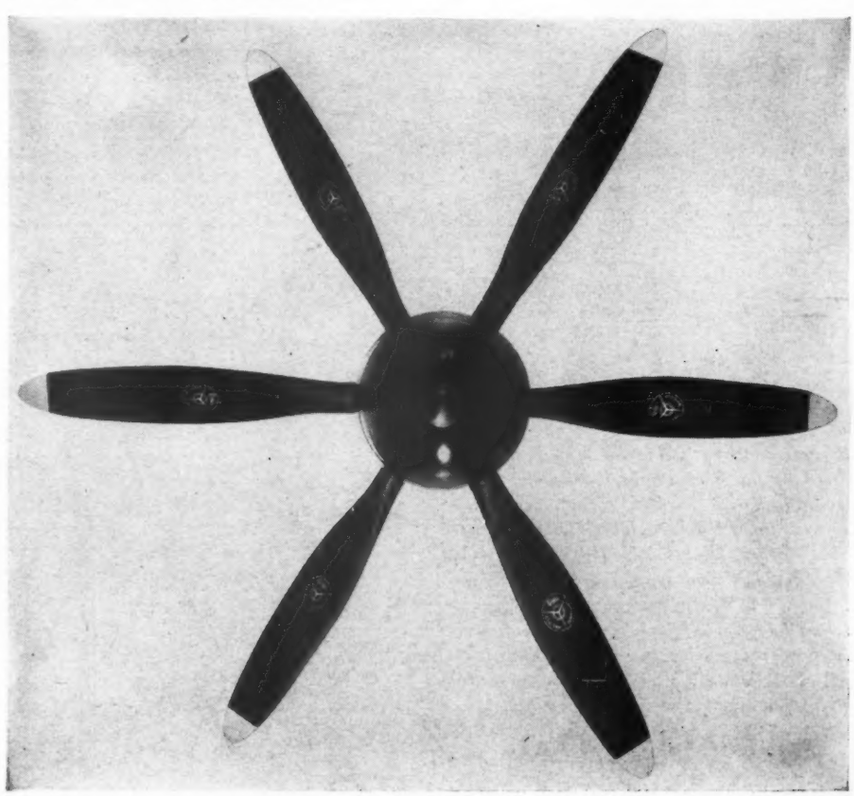
Cooling baffles and push-rod housings, formerly requiring five operations, are now made in one manufacturing operation. They are formed under applied heat and pressure in molds with a base material, such as cotton fabric, being impregnated with phenolic thermosetting resin. The new parts are free of any critical material.

Developed in cooperation with the Panelyte Division of the St. Regis Paper Co., the new parts have been fully flight tested and are now in quantity production for use as standard units on all Wright engines.

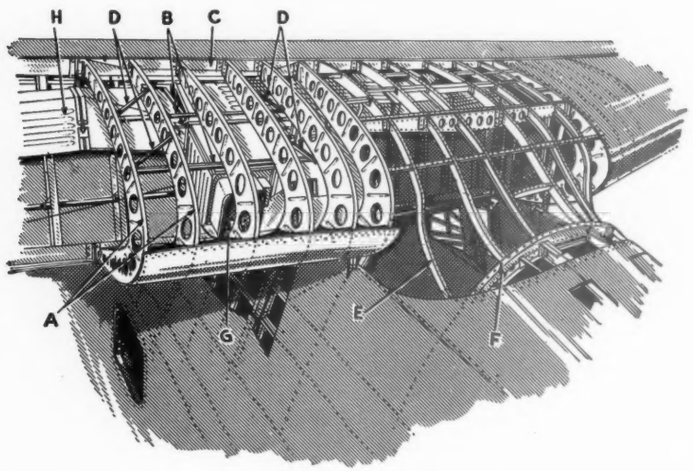
M. B. Gordon, vice-president and general manager of Wright Aeronautical Corp., said that in addition to saving thousands of pounds of aluminum monthly, the plastic material more than doubles the service life of the parts involved, decreases engine weight and materially reduces manufacturing time and costs.

COAXIAL ELECTRIC PROPELLER DEVELOPED BY CURTISS-WRIGHT

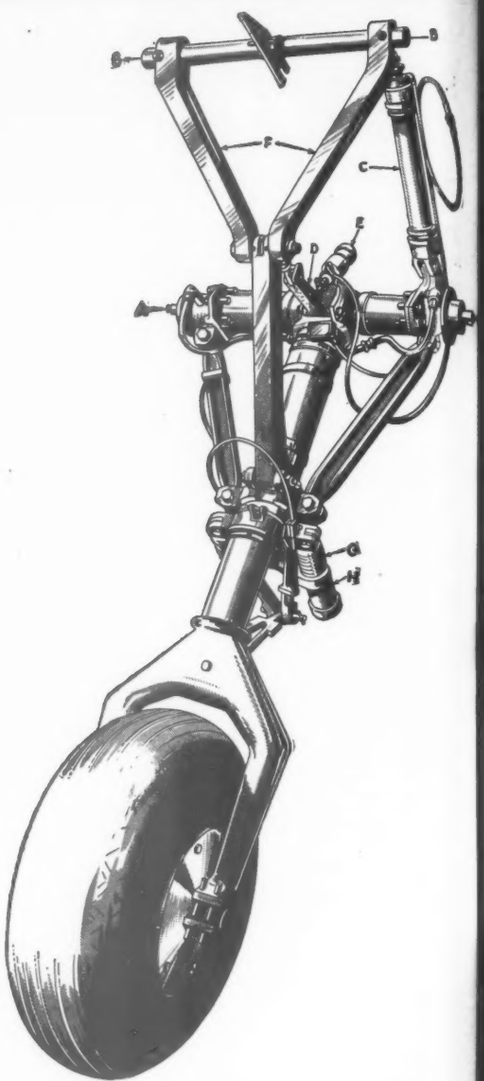
A heavy duty six-bladed dual rotating propeller designed to more efficiently utilize the tremendous power generated by modern aircraft engines has been developed and is being delivered to the Army Air Forces for installation in fighting planes. Robert L. Earle, vice-president and general manager of the Propeller Division of Curtiss-Wright Corp., in making the disclosure, said the propeller was designed primarily to increase the efficiency of high altitude airplanes with 2,000-hp. engines, particularly those in which propeller diameter must be restricted. The propeller is full feathering, electrically controlled and has hollow steel blades. Two sets of three blades rotate in opposite directions, eliminating torque effect, which greatly improves the control of high performance single-engine types.



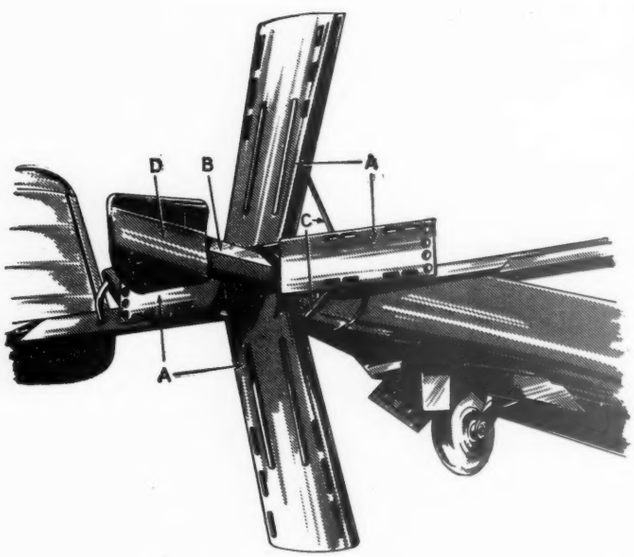
SKETCH BOOK of Design Detail



The leading edge center section of the Vought-Sikorsky VS-44-A with the upper wing covering removed shows the stamped nose ribs "A." The ribs are held parallel by channel sections "B" and are attached to the front spar "C." Diagonal braces "D" are also used. Fuselage stringers over the pilots' cabin are channel sections "E" which lead from the fuselage bulkhead "F" to the spar "C." The intake "G" leads to the air duct "H" located inside the nose wing section.

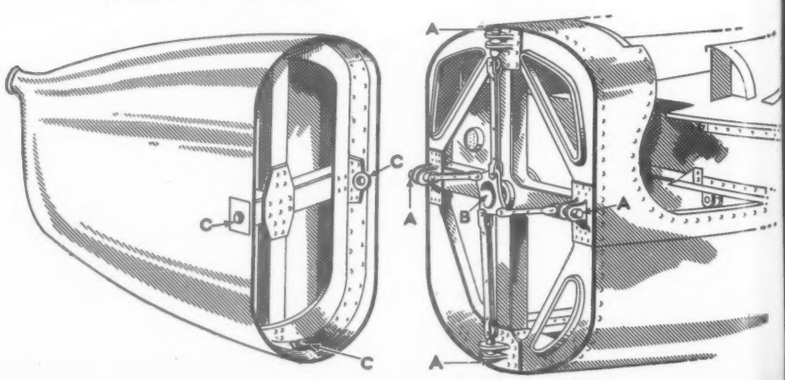


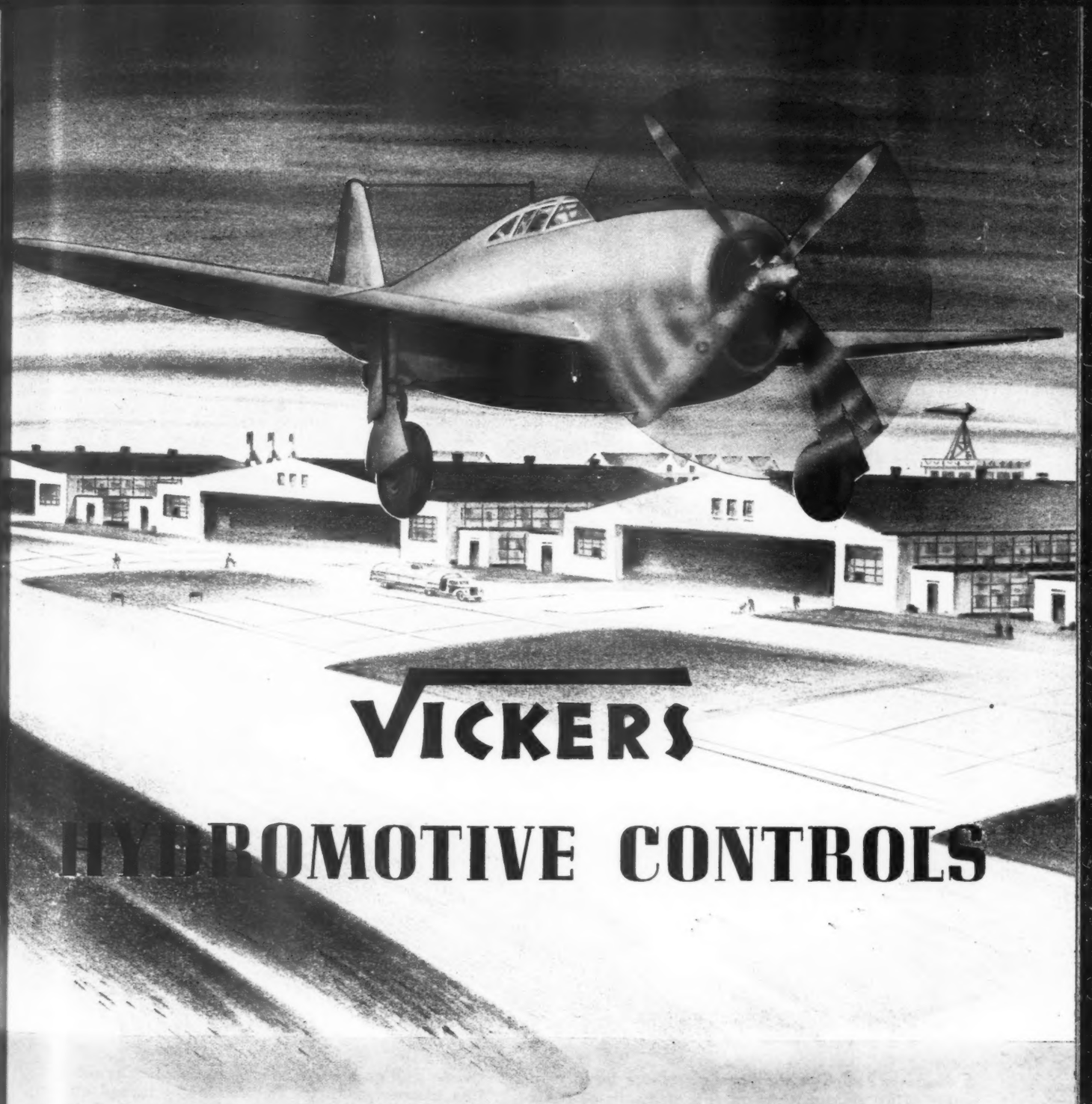
Shown here are details of the retractable nose wheel of the tricycle landing gear of the Douglas C-54 cargo plane. The main pivot of the gear is along the axis "A-A" which rotates in bearings fixed on the side of the nose wheel well. Axis "B-B" is the forward rotating axis for the upper retracting links also held by bearings fixed to the side of the nose wheel well. The gear is retracted hydraulically by an actuating cylinder "C." The links "D" hold the gear in locked down position by means of a spring encased in the cylinder "E" which is a one-way acting hydraulic cylinder. The gear retracts by hydraulic pressure actuating cylinder "E" which breaks the links "D" allowing the main retracting cylinder "C" to extend, rotating the oleo up and forward and also rotating the upper retracting links "F" upward and aft, which also tends to lift the gear. The rings "G" are supports for the nose wheel steering cylinders "H" which are actuated hydraulically.



Illustrated above is the new type brake being fitted by the Germans to the Dornier 217 to make it a dive bomber. Shown here in the dive position, the four slotted flaps "A" have been opened by being pulled forward along the beam "B" and supported by the connecting rods "C." In closed position the flaps are faired into the tailpiece "D." The entire unit is detachable, being replaced by the shorter unit at right when the plane is being used in its normal function as a level bomber.

The detachable tail unit of the Dornier 217 is shown below. The four plungers "A" are extended by the four-lobe bell crank "B," to go in the fittings "C." This unit is replaced by the brake unit to convert the plane from a level- to a dive bomber.





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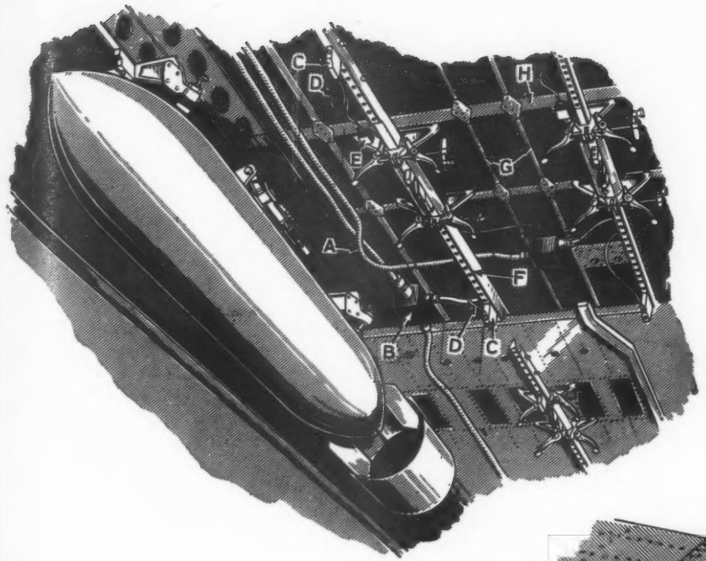
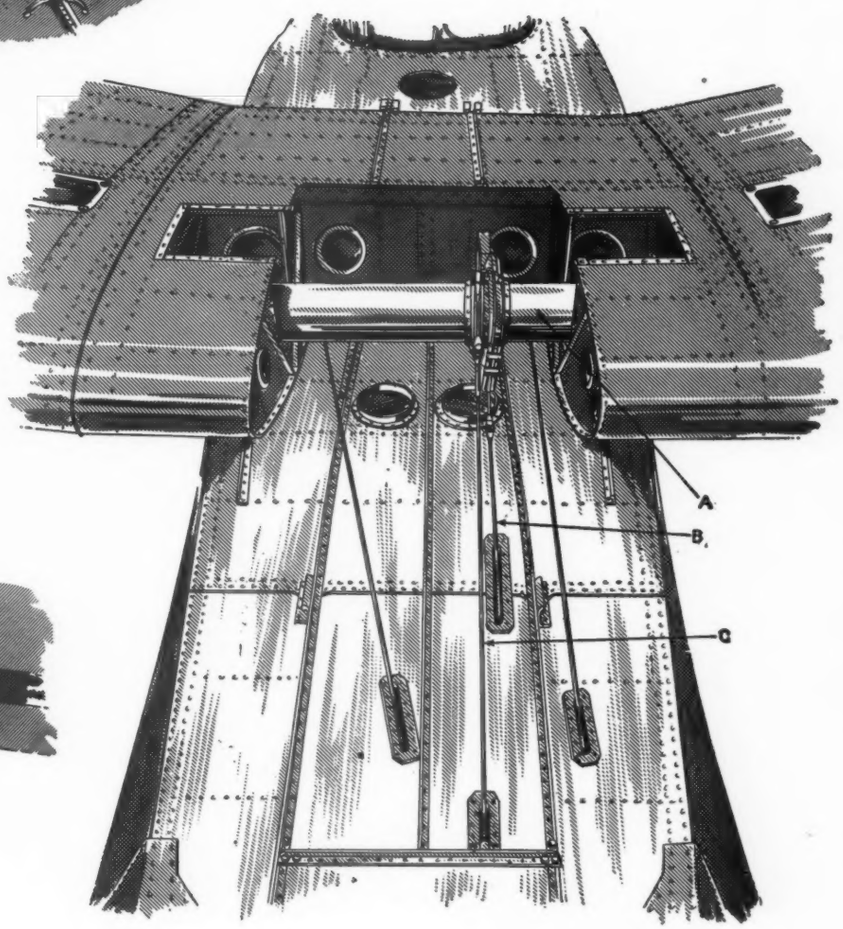
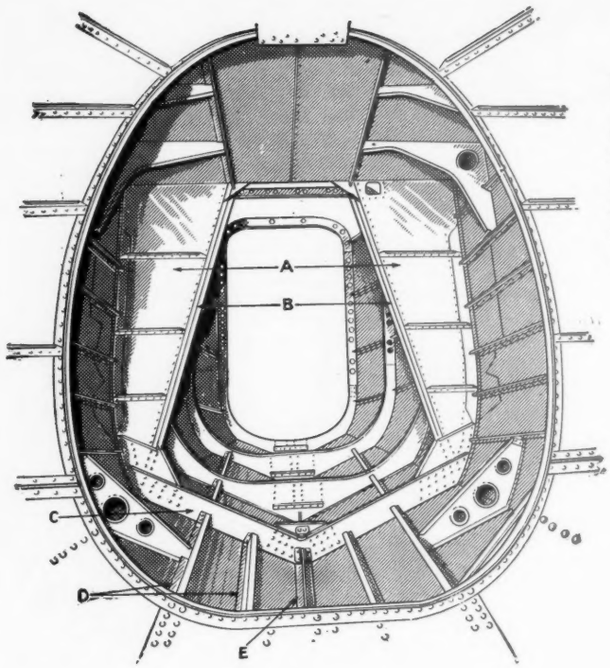


Shown at left are details of the bomb racks of the twin-engine Manchester heavy bomber, with one of the large bombs in place. The conduit "A" carries the firing impulse from the bombardier's release-button to the distributor box "B." The impulses then go to connector-boxes "C," then through cables "D" to the trigger "E." Different sized bombs may be carried for different missions through adjusting the bomb locking pins at varying lengths through the holes "F" in the bomb rack. Note the large size and apparent strength of the longerons "G" and cross members "H" through which the bomb load is distributed.

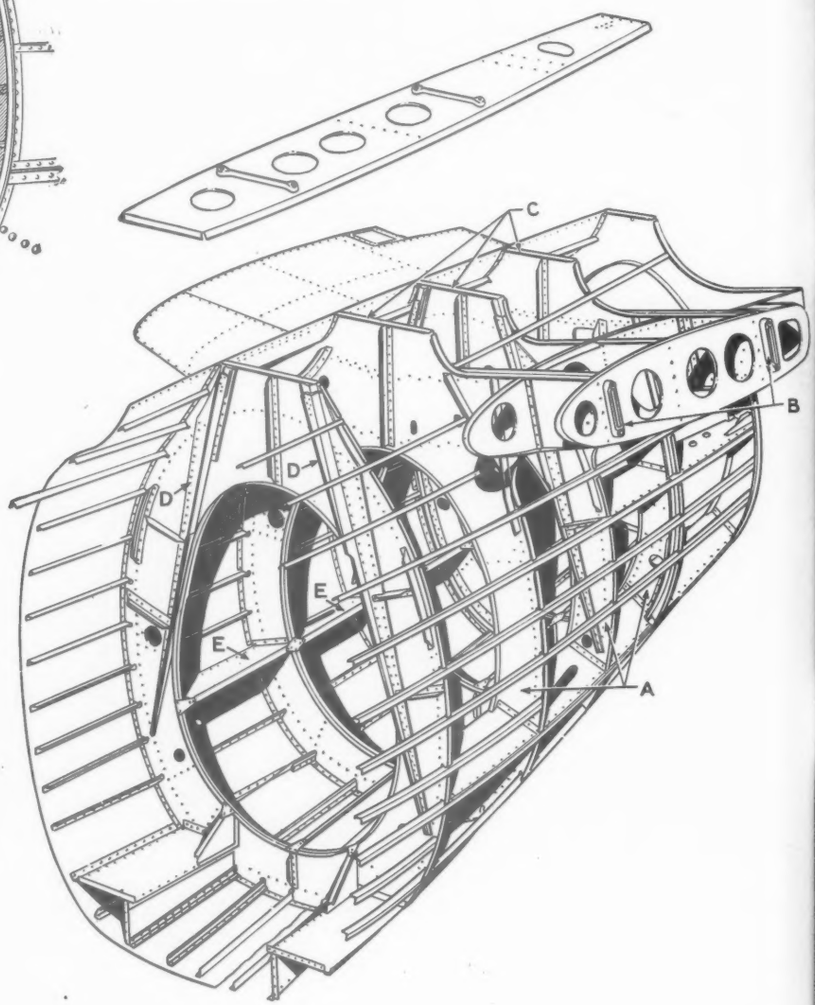


The elevator control torque tube of the Vought-Sikorsky VS-44-A is shown at the right. The torque tube "A" is actuated by the cables "B" and "C" which are attached to bellcranks on the tube. The leading edge of the stabilizer is flush riveted, with round headed rivets from there on back. The elevators are fabric covered.

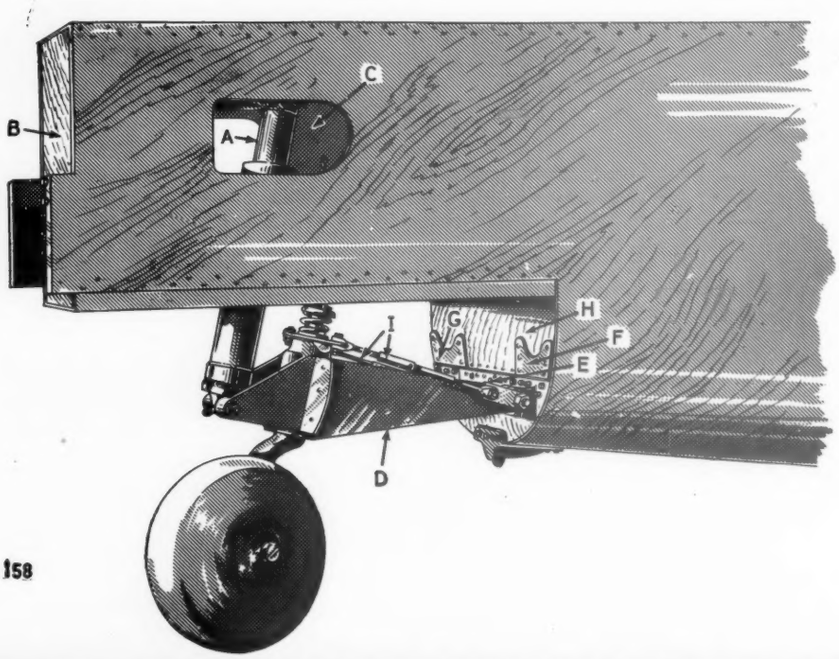
The right side of the inward retracting landing gear of the Focke-Wulf 190 is shown at left. The locking mechanism at "A" is electrically operated, as is the retracting gear itself, which pivots the rod "B" in and up to pull the gear into the well. Travel of the rod tightens the cable "C" which retracts the tail wheel, thus eliminating the need for a separate power unit for that part of the landing gear. "D" is the line from the cockpit to the hydraulic brake. Note that the fairing "E" comes only a little way below the hub of the wheel; another piece on the fuselage moves in behind the retracting wheel to complete the enclosure. (For other details of the Focke-Wulf 190 see AVIATION, October, 1942, page 233.)



The hull-tail frame construction of the Vought-Sikorsky VS-44-A is shown at the left. The spar for the vertical fin is attached to the bulkhead "A" which is reinforced with angles "B" to distribute the load. The bottom of this bulkhead "C" is heavier than the other bulkheads in this section to absorb the fin loads. Attached to the bulkhead are bottom stringers "D" and the keel "E" which at this station is a T-section. (See also AVIATION's Sketch Book for March, May, June and October, 1942.)



Construction of the Douglas A-20 fuselage where the stabilizer and fin are attached is shown at right. The root spars are integrated with the fuselage bulkheads "A" in much the same manner that a wing center section is joined to the fuselage. The outer panel of the stabilizer is attached to the roof by four bolts at the fittings "B." The fin is attached to the fuselage on the same bulkheads along the flat surfaces "C." Note the reinforcing angle stringers "D" along the forward bulkhead and those between the bulkheads "E."



The tail wheel installation of the North American trainer in which the aft section of the fuselage is built of plywood is shown at left. The oleo "A" is attached to longitudinal members between the bulkheads "B" and "C." The V-frame "D" hinges on the metal frame "E" with the plates "F" and "G" taking the load into the bulkhead "H." The rods "I" are for steering. (See also AVIATION's Sketch Book for August and September, 1942.)

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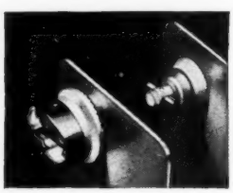
Of added interest to engineers, production and purchasing executives is the fact that Camloc, more than ever, is the *economical* fastener. By saving precious installation time, it lowers production cost. And now greater volume has permitted a substantial price reduction!

CAMLOC FASTENERS ARE 4 TO 10 TIMES FASTER!

One of the most important of Camloc's many advantages is the fact that the Stud Assembly is a *single* unit assembled at the Camloc factory. That means the cross-pin need never be removed. It is staked, and additional safety is provided by a dam at the end of the Cam Collar detent. Only the simple Camloc hand plier is needed to insert the stud into the Grommet. This is of special advantage in installation, particularly when sheet warpage and accumulated tolerances occasionally necessitate the use of different length studs than those specified originally. Camloc is *four to ten times faster* in installation than other fasteners, and permits tremendous savings in labor time and production expense.



CAMLOC FASTENER CO., 420 Lexington Avenue, New York, N. Y.

Representatives: A. B. Boyd Co., Los Angeles • San Francisco • Portland • Seattle • S. A. Long Co., Inc., Wichita

POWER PRESSES

Die Cushion Size and Ring Holding Pressure Required

(When dimensions of first drawn shell are available)

TO OBTAIN the correct draw ring holding pressure for the first draw on a given shell—of one operation or more—the circumference and the thickness of the first draw are required. This also applies to irregular drawn shells.

To find the size of cushion or the draw ring holding pressure required, proceed as follows:

Multiply the circumference of the first drawn shell by the thickness of the stock. This is the cross-section area at the drawn diameter. Then multiply the factor in the table corresponding closest to the thickness of stock used. The result will be the ring holding pressure required by the pneumatic die cushion. Next, select a pneumatic die cushion, from the specifications shown in the catalog as to ring holding pressure. Taking the pressure required, and dividing by the piston area, you will get the result of the air pressure required by the pneumatic die cushion to draw the shell. If this pressure is higher than what is available from the shop air line, or, that can be supplied, a cushion must be selected to suit the maximum shop air line pressure available. Rules for various thickness of stock follow:

Thickness of Stock	*Pressure in Lb. Required*	*Thickness of Stock*	*Pressure in Lb. Required*
.010	30,000	.060	8,000
.015	27,500	.065	7,500
.020	25,000	.070	7,000
.025	22,500	.075	6,500
.030	20,000	.080	6,000
.035	17,500	.085	5,500
.040	15,000	.090	5,000
.045	12,500	.095	4,500
.050	10,000		
.055	9,000		

ON ALL THICKNESS of stock greater than 0.100 in., a factor in the table of 4,000 can be used satisfactorily. For example, the first draw on a given shell, 4 in. in diameter, stock thickness of 0.040 in., the circumference is approximately 12 in. Thus, 12 in.x0.040 in. equals 0.48 sq. in. of cross-section area at the drawn diameter of this given shell. From the table we find that for 0.040 in. stock, we require 15,000 psi.; thus, we have 0.48x15,000, which equals 7,200 lb. ring holding pressure to be supplied by the pneumatic die cushion. From the catalog, we find a 12-in. pneumatic die cushion has 113 sq. in.; thus, 7,200 divided by 113, equals 63 lb. pressure at which the cushion should operate. If this pressure can be supplied, the cushion is suitable. The ring holding pressure required on various thickness of stock is as per cross-section area, which varies with the thickness of stock—the thinner stock requiring greater ring holding pressure. The cushion selected should be from the dimensions and specifications shown in the catalog, so that it will pass through the press bed opening. If a single cushion will not give the desired ring holding pressure, a tandem type will have to be used. In general, it is good practice to equip the average press with ring holding pressure, on 100-lb. air line, having one-sixth of the total press tonnage.

NOTE: Stripping Pressure Required on Compound Blanking and Piercing Dies: (Formula) $L \times T \times 3{,}500 = SP$.

T=thickness of material to be stripped from compound punch.

L=Length of stripped section of blank or circumference.

SP=stripping pressure required by pneumatic cushion in pounds.

Courtesy of Dayton Rogers Manufacturing Co.

FLOW PRODUCTION OF EXHAUST MANIFOLDS is an accomplished fact at Ryan. The difference between flow production and usual job shop methods involves nearly every phase of plant operation: engineering, tool planning, production control, quality control and plant layout. The result is a uniformly better product, produced in greater volume in less time. Rely on Ryan for manifold research and development; for engineering vision that sees through service problems. Now add FLOW PRODUCTION and you have the answer to your manifold problems whatever they may be.

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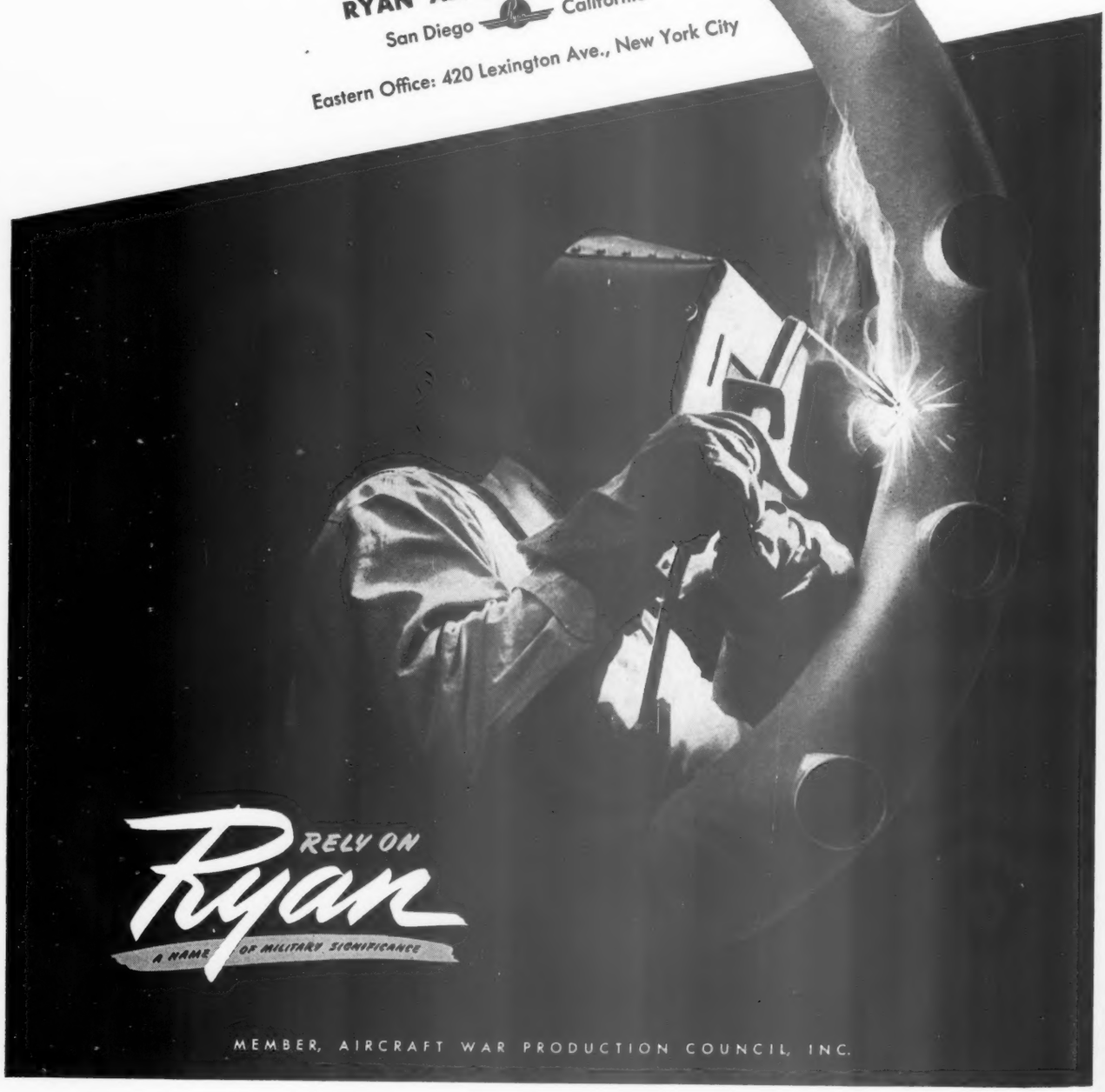

MEMBER, AIRCRAFT WAR PRODUCTION COUNCIL, INC.

POWER PRESSES

Cushion Engineering Data

Tonnage Capacities on Presses

Capacity of Crankshafts at the Bottom of the Stroke

Crank Shaft Dia. Inches	TONS		Crank Shaft Dia. Inches	TONS	
	Single Crank Press	Double Crank Press		Single Crank Press	Double Crank Press
1 3/8	6	.....	6 1/2	150	150
1 1/2	7.5	.....	7	180	180
1 5/8	9	.....	7 1/2	215	215
1 3/4	10.5	.....	8	255	255
1 7/8	12	.....	9	345	345
2	14	.....	10	440	450
2 1/8	16	.....	11	545	650
2 1/4	18	.....	12	665	900
2 1/2	22	22	13	790	1150
2 3/4	26.5	26.5	14	920	1400
3	31.5	31.5	15	1060	1700
3 1/4	37	37	16	.....	2000
3 1/2	43	43	16 1/2	1300	.....
4	56	56	17	.....	2300
4 1/2	71	71	18	1560	2700
5	88	88	20	1950	.....
5 1/2	106	106	22	2380	.....
6	126	126	24	2860	.....

The tonnage figures do not apply to end wheel type of presses with overhanging crank-pin.

IT IS CUSTOMARY PRACTICE to equip the average press with draw ring holding pressure one-sixth of the total press tonnage. In doing so, you are always assured of equipping your press with the *maximum* size cushion that will operate satisfactorily on a given press. On the average inclinable press, it is usually necessary to resort to tandem construction. To figure the draw ring holding pressure produced by a pneumatic die cushion, multiply the surface of the piston or pistons, in square inches, by the air pressure used on the given cushion, in square inches. Example: If an 8-in. size cushion is used, surface would be 48 sq.in. If the working pressure from the shop air line to the cushion was 50 psi., 50 times 48, equals 2,400 lb., which would be developed on the draw ring. In other words, on a 50-lb. maximum shop air line, using an 8-in. cushion, the approximate maximum draw ring holding pressure available would be 1 1/5 tons.

Courtesy of Dayton Rogers Manufacturing Co.

Information Tips

Keep UP-TO-THE developments with

This AVIATION Reader's Service is being made available through the cooperation of manufacturers to help executives save that invaluable item—time. It is your service to use—a service which can mean a profit in both time and convenience.

1

Magnaflux Inspection—Two brochures describing new technique for detection of structural flaws by fluorescence under black light—Magnaglo for magnetic metal parts and Zyglo for non-magnetic parts—developed by the Magnaflux Corp., 5908 Northwest Highway, Chicago, Ill.

2

Relay and Timer Guide—Designed to serve as a guide to relay and timer selection and usage is the new *Dunco Relay-Timer Catalog.* It is fully revised, profusely illustrated and contains detailed specifications and engineering information. The catalog introduces a new type designation system said to simplify specifying of required special features on units which are otherwise standard. Electrical information, base and cover dimensions, coil data, magneto structure diagrams and dimensions, contact diagrams and mounting styles are also included. Struthers Dunn, Inc., Juniper & Cherry Sts., Philadelphia, Pa.

3

Airport Runway Construction — Condensed information from recent reports on design and construction of airport runways and highways is available in *Better Bases for Better Surfaces,* published by Solvay Sales Corp., 40 Rector St., New York, N. Y.

4

Cowl Fasteners—Nearly 50 illustrations and diagrams are included in the new service bulletin covering installation and maintenance of Camloc aircraft cowling fasteners. The Camloc Fastener Co., 420 Lexington Ave., New York, N. Y.

5

Press Brakes—A new profusely illustrated catalog on press brakes and their uses, showing applications, giving bending and punching load charts, features for special work and several pages of dies and their uses, has just been issued under the designation Catalog B-1 by the Cincinnati Shaper Co., Cincinnati, Ohio.

6

Mounted Wheel Manual—Edited for wartime uses is a new booklet on the use of mounted wheels and accessories for portable tools, featuring colored illustrations correct within a few thousandths of an inch and showing a wide variety of portable tools accessories, including miniature steel cutters, polishing wheels, sanding drums, disks and many other production time-savers. Published by the Chicago Wheel & Manufacturing Co., 1101 W. Monroe St., Chicago, Il.

7

Cutting Tools—A 6x9-in. condensed catalog covering its complete line of cutting tools has been made available by the Genesee Tool Co., Fenton, Mich. It illustrates and lists sizes of standard tools available and also shows a large number of group photographs of special tools which the company is equipped to produce. It also contains tables covering standard items such as standard keyways for cutters, dimensions of Morse and B & S taper shanks, weight per inch of round bars, etc.

8

Data Chart—A pocket-sized slide chart called the *Summary of Technical Data on Carpenter Stainless Steel,* which gives general characteristics of any stainless steels, such as analysis, magnetic properties, heat treatment, toughness, hot work properties, etc., has been prepared by the Carpenter Steel Co., 128 Bern St., Reading, Pa.

9

Grinding Wheel Care—A new 26-page, illustrated data booklet titled *Grinding Wheels, Their Construction and Selection* containing tables and charts detailing grain and grade specifications, recommended grinding wheel speeds, minimum spindle diameters and wheel weights, functional facts of grinding wheel operation and a section on honing and superfinishing stones has been published by Mid-West Abrasive Co., 1960 E. Milwaukee Ave., Detroit, Mich.

10

Steel Handbook—A revised edition of the *Handbook of Special Steels* incorporating information on various grades of stainless, tool and other special alloy steels particularly adapted for design engineers and production men contains data for selection, treatment and use of these steels, with finder charts and tables to facilitate reference. The Allegheny Ludlum Steel Corp., Pittsburgh, Pa.

11

Construction Glues—The title of an eight-page illustrated bulletin on use of glues in construction work, designed for those utilizing this new technique for the first time. Published by I. F. Laucks, Inc., 911 Western Ave., Seattle, Wash.

12

Hydraulic Presses—An eight-page, illustrated folder describes hydraulic presses, including a giant 7,200-ton forging and extrusion press being set up for aircraft manufacture, is available from Hydraulic Press Division, A. B. Farquhar Co., Ltd., York, Pa.

13

High Cycle Generation—A four-page brochure illustrating and describing Burke high cycle generation sets for high speed tools. Burke Electric Co., Erie, Pa.

14

Engine Care—A technical bulletin describing the three fundamental steps necessary in aircraft engine cleaning and paint stripping for major overhaul has just been published by the Curran Corp., 6 Pleasant St., Malden, Mass.

15

Recessed Head Screws—A 44-page, illustrated catalog, including price list, of recessed and slotted wood, sheet metal, machine, cap and set screws and machine screw and wing nuts, rivets and burrs, rods and specialties manufactured by Reed & Prince Mfg. Co., Worcester, Mass.

16

Gaskets, Packings and Seals—An eight-page illustrated brochure with drawings covering cork compositions, cork-and-synthetics, synthetics, cork-and-rubber, and fibrated leather products of Armstrong Cork Co., Lancaster, Pa.

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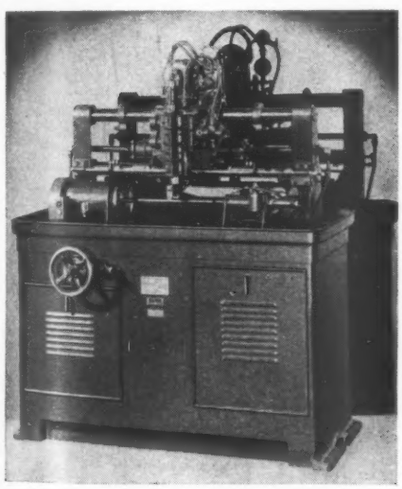
MODERN MACHINE TOOLS

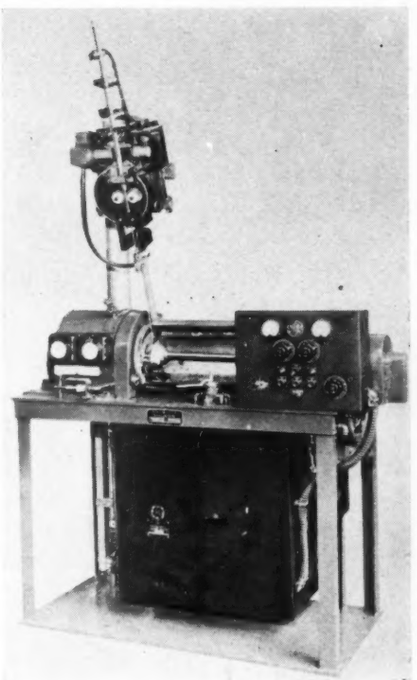
17

Superfinishing Machine

The **Foster Division** of **International Machine Tool Corp.**, Elkhart, Ind., has added a 4x36-in. model and made improvements on its 4x18-in. model superfinishing machines. The machines are



reported capable of developing finish of 2-5 micro-in. on cylindrical work such as shafts used in aircraft engines where surface scratches and defects must be eliminated. The machines are equipped with manually controlled variable-speed drive to the spindle, and a variable-speed drive to the oscillating head. This head is also provided with a longitudinal hydraulic traverse, the speed of which may be varied from 0 to 30 in. per min. Bed casting is heavy and rigid to eliminate vibration damage to the finish. Drive for the head, hydraulic pressure pump and reservoir and cutting fluid pump and reservoir are located within the bed. An enclosed ball bearing motor drives the variable-speed transmission, providing an unlimited number of spindle speeds from 25 to 690 rpm. Oscillating head carriage is longitudinally traversed by a double-end hydraulic cylinder bolted to the back side of the head carriage. A fixed piston rod, arranged with a single piston, causes travel of the cylinder and head in either direction. Traverse rate may be varied from 0 to 30 in. per min. through an aperture control valve. Three or four jaw, or collet-type chucks may be used on the machines.—AVIATION, *November*, 1942.



18

Automatic Arc Welder

A new unit for automatic arc welding with heavily coated electrodes in cut lengths has been developed by the **General Electric Co.**, Schenectady, N. Y. In addition to the complete unit, the essential elements of the equipment are being made available so that automatic arc welding heads originally designed for operation with thyratron controlled coiled electrodes can be converted for welding with stick electrodes. The unit is said to be particularly adaptable to work where one or more complete units can be made with a single electrode,

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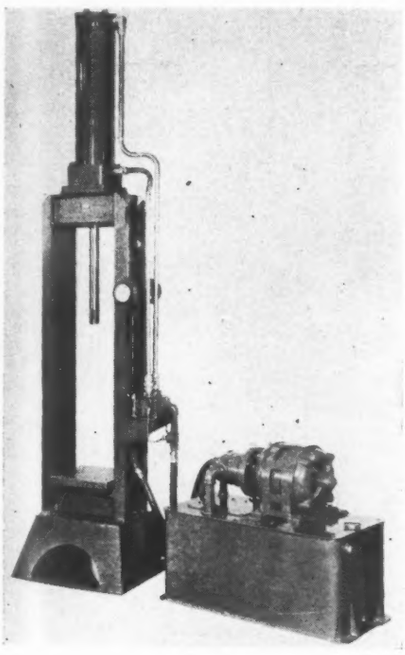
such as tubular assemblies where the starting and finishing ends of a single weld speed overlap. In operation, the welder inserts an electrode in the clamp, presses the start button, and the equipment strikes and maintains the arc, feeding the electrode at proper rate to maintain the preset arc voltage. Welding continues until stopped by a limit switch, at which time the electrode clamp returns to starting position to receive a new electrode.—AVIATION, *November,* 1942.

19

Hydraulic Press

Hydraulic Machinery, Inc., Detroit, Mich., is introducing a 25-ton pressure press of the following specifications: 30 in. stroke, 60 in. of daylight, 4.4 in. per. sec. closing speed, .8 in. per sec.

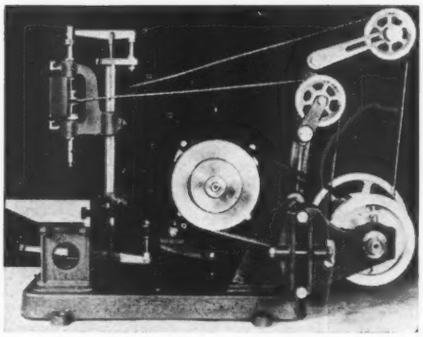


high pressure speed, 5 in. per sec. opening speed, 25 in. from floor to 18x18 in. platen, combination pump, relief, check and unloading valve, 7½ hp. 1,200 r.p.m., 3 hp. 60 cycle motor. The press is of welded steel construction mounted on a flared base 30x30 in. and the overall height is 139 in. Power unit may be installed in another room or building.—AVIATION, *November,* 1942.

20

Sensitive Drill Press

A new Supersensitive Drill Press for extremely small drills and other tools is announced by the **Edward Blake Co.**, 634 Commonwealth Ave., Newton Centre, Mass. The machine has a standard range of eight speeds from 3,000 to 23,000 rpm., said to give proper surface speeds on drills from .004 in. or smaller



to 1/16 in. diameter. Sensitivity is attained by balancing the spindle by means of the vertical component of the belt tension. Machines with one, two, three and four spindles can be furnished. Each spindle is equipped with an independent finger tip control and each spindle may be run at an independent speed to suit the size and type of tool being used and material being cut. Standard equipment includes two spindles for each spindle mount, one for Jacobs cut and one with tapered hole for tapered shanks.—AVIATION, *November,* 1942.

21

Hand Screw Machine

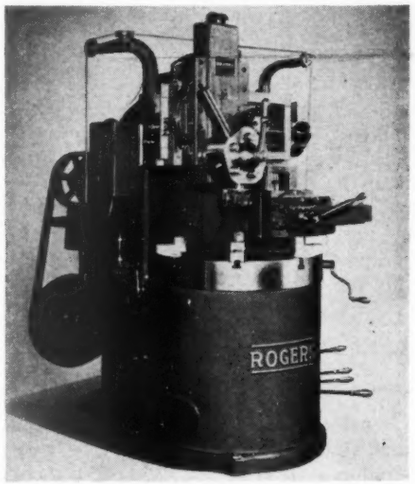
Developed to meet the need for tools capable of accurate and continuous production, the No. 830 hand screw machine with capacity for ⅝-in. round bar stock has been introduced by **Logan Engineering Co.**, 4901 Lawrence Ave., Chicago, Ill. Features of design and construction listed by the manufacturer include: precision ground bed with two prismatic V ways and two flat ways; precision, pre-loaded ball bearing spindle mounting; turret holes bored from the headstock; turret and cross slide provided with adjustable jibs to compensate for wear. A new speed collet chuck for round work which may be fed through the spindle and a bar feed attachment are offered as accessories.—AVIATION, *November,* 1942.

New Products

22

Vertical Turret Mill

The "Perfect 36" vertical turret mill for boring, drilling and turning ferrous and non-ferrous castings, forgings and similar pieces, has been introduced by the **Rogers Machine Works, Inc.**, 125 Arthur St., Buffalo, N. Y. The specially designed swivel head and main head permit two operations simultaneously. Incorporating the swivel design in the side head, quicker and simpler tool setting for irregular pieces is said to



be possible due to the ability to set the side head at any angle up to 35 deg. either way. In addition to the swivel side head and "table level" horizontal chuck, the mill has a motor-driven traverse, heavy duty main clutch running in an oiltight case. Main and side heads have 8 vertical and horizontal feeds each.—AVIATION, *November,* 1942.

23

Balancing Machines

Available in a variety of models ranging from bench size to large floor- and pit-type models, the balancing machines produced by **Bear Mfg. Co., Industrial Division**, Rock Island, Ill., are said to show both angular position and amount of unbalance at the same time. It is said that with the machines it is unnecessary to static balance before a dynamic balance test can be made, and that the machines reveal whether a static or dynamic unbalance is present without reversing ends of the body being balanced.—AVIATION, *November,* 1942.

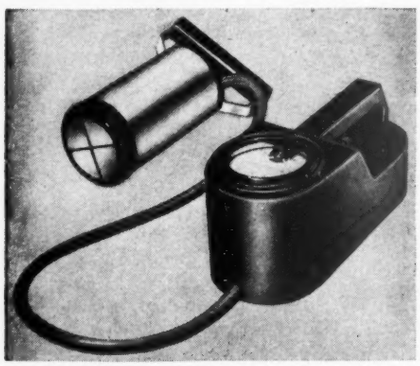
SHOP EQUIPMENT & ACCESSORIES

New Products

24

Moisture Registers

Two new moisture registers especially adapted to aircraft work have just been developed by **Moisture Register Co.**, 5117 Kinsie St., Los Angeles, Calif.



One model has been designed for use with regular lumber, the other a variation for testing veneers and plywood as thin as $\frac{1}{8}$ in. It is said tests can be made practically instantaneously, and very little training is required to use the units since results are shown on reading dials. The instruments are portable, the total weight being but 5 lb.—AVIATION, *November,* 1942.

25

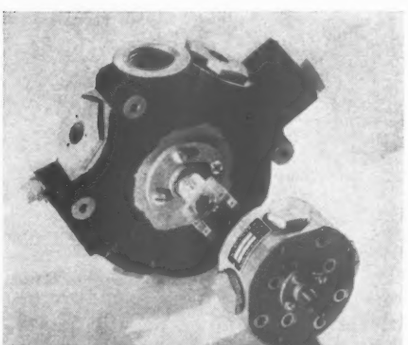
Air-cooled Welder

A new air-cooled heavy duty welder, designated the 250 F has just been introduced by the **Ergolyte Manufacturing Co.**, Lawrence St. at Erie Ave., Philadelphia, Pa. The air cooling is designed to reduce the thermal stress which strains the insulation of ordinary machines, making it particularly adaptable to constant work necessary for today's production schedules. Capable of handling an electrode from $\frac{1}{16}$ to $\frac{5}{16}$ in., the new model has 24 heat steps, an input voltage of 230 volts and a current range of from 15 to 250 amp. The 250 F has a 60 cycle frequency and operates on a single phase or one phase of a two or three phase current.—AVIATION, *November,* 1942.

26

Selector Valves

Two new four-way hydraulic selector valves, just announced by **Bendix Aviation, Ltd.**, North Hollywood, Calif., bring its line to nine models, covering every tube size and style from $\frac{1}{4}$ in. to

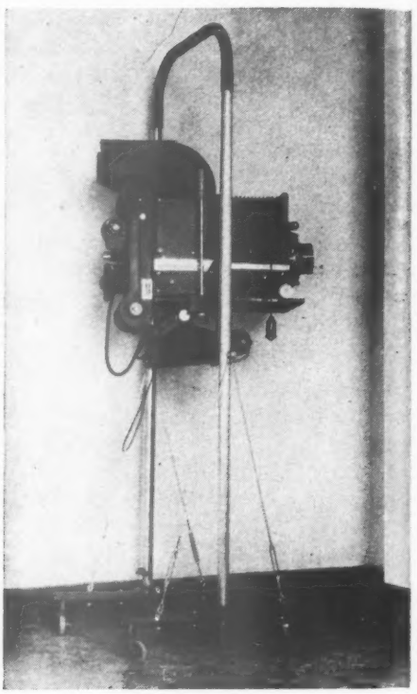


$\frac{3}{4}$ in. including dual and triple bank valves. All duplicate the basic radial design using co-axial shafts which permit all handles to be operated simultaneously when desired. Fewer parts, low pressure drop, and plastic poppets are features of the Bendix valves. The newest models are for $\frac{3}{4}$-in. tube size with integral check and relief valves, and for $\frac{3}{8}$-in. tube size.—AVIATION, *November,* 1942.

27

Reflex Camera

A highly mechanized camera which has been used to photograph monometer readings has been developed by the **Motoflex Camera Corp.**, 271 Madison Ave., New York, N. Y. It differs from other reflex cameras in that upright as well as inverted image is visible up to the moment of exposure. The image may be viewed by means of an auxiliary mirror when the camera is above eye level. A new type, electrically operated by-pass shutter requires no manual re-setting for taking consecutive pictures. Exposure range is from 1/120 sec. to $1\frac{3}{4}$ sec., with the exposure dial being illuminated like a radio dial.



Three sizes of pictures can be made: $3\frac{1}{2}$x5; 4x5 and 5x7 with capacity for 344, 300 and 171 negatives respectively. New film is automatically moved into place after each exposure. As each film is exposed, an identifying number is automatically flashed on the margin, forming a permanent record. In addition, the camera has two other counters; one to keep track of the number of exposures made for each subject and one that records the amount of film used and the amount still left in the camera. An electrically operated mechanism makes it impossible to operate the camera until the safety slide has been removed. Remote control is also provided. The camera is approximately 1 ft. high and wide by 14 in. long and weighs less than conventional studio cameras.—AVIATION, *November,* 1942.

28

Adjustable Service Stand

A new portable and adjustable work platform for servicing large aircraft has been developed by **Pacific Engineering Corp.**, 3123 San Fernando Road, Los Angeles, Calif. Height can be adjusted from 3 to 10 ft. by means of hydraulic strut equipped with mechanical safety pin. Of all-steel construction, the stand is designed to safely support

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WOOD

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LOCKERS
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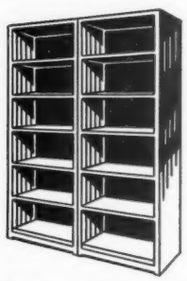
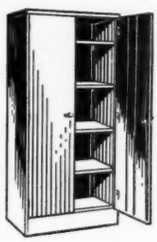
SHELVING



CABINETS



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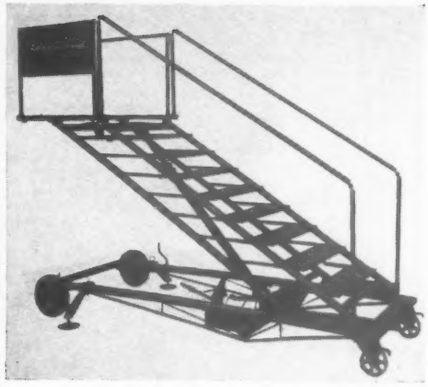


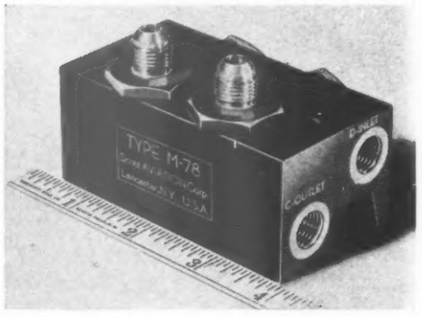
loads up to 1,500 lb., with a base of 4x11 ft. assuring safety. Stabilizing braces resting on large diameter steel pads permit solid footing on uneven ground and assure equalization of the working platform. The platform can be moved by attaching to a car or truck by means of a telescopic tow bar. While being towed the platform rolls on two 16-in. air wheels.—AVIATION, *November,*

New Products

30

Oxygen Manifold

Scott Aviation Corp., Lancaster, N. Y., announces an oxygen manifold, a precision accessory designed to direct



the flow of oxygen from an outside source to service tanks, from service tanks to the regulator or to other equipment necessary on systems essential to high altitude aircraft performance. The new unit has been designed to prevent loss of total oxygen supply in event of a direct tank hit and is reported capable of serving any number of tanks either centrally located or dispersed throughout the plane.—AVIATION, *November,* 1942.

29

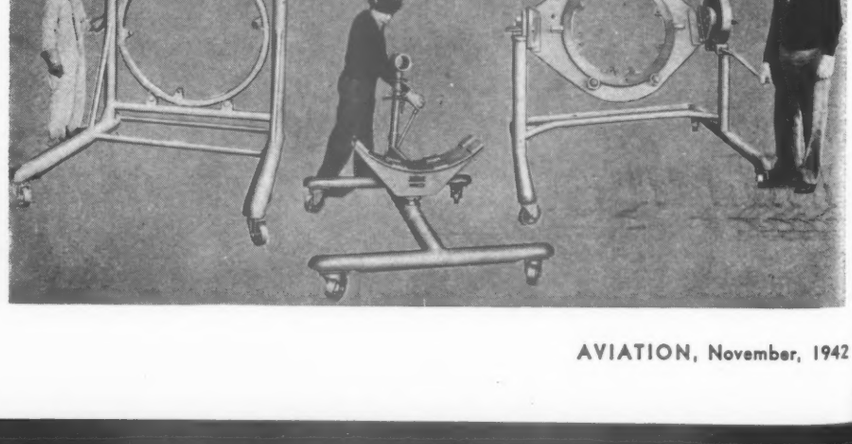
Matched Assembly Units

A trio of matched assembly units, called the ETN group, designed to facilitate handling and moving radial aircraft engines from packing case through final stages of engine nacelle build-up has been introduced by **Aviation Division, Whiting Corp.**, Harvey, Ill. The group includes: Model E engine cleaning stand for initial operations including preliminary accessory installation; Model T engine transfer carriage, which fits into the other two units to simplify transfer of engine from one to the other without overhead handling and for additional accessory installation; and Model N, rotatable nacelle build-up unit, which provides support for final accessory, cowling, plumbing, wiring and other installations. Tubular construction provides simple design with maximum accessibility. The units are available in various capacities for all sizes of large radial engines.—AVIATION, *November,* 1942.

31

Screw-Holding Screw Driver

A non-magnetic screw-holding screw driver has been developed by **Millen Mfg. Co.**, 262 Washington St., Boston, Mass. A gripping lever moves in and out of the grooved blade to hold the screw securely while it is being started or driven. This is operated with one hand, and comprises but two moving parts: the lever itself and a slide, placed near the handle, which is moved

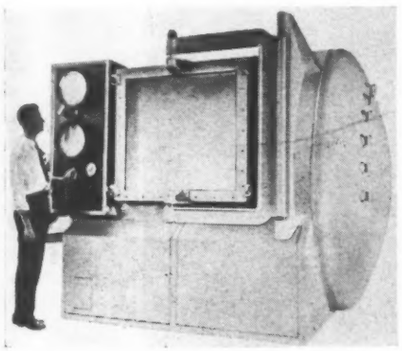


down to grip the screw, up to release it. It is said the driver can be used with screws of any material—brass, steel, aluminum, fiber, etc., to eliminate use of wires, pliers, glue and other means of holding screws in places where the operator's free hand cannot reach. —AVIATION, *November,* 1942.

32

Parts Testing Chamber

To test aircraft parts and radio equipment used in high altitude work, **Kold-Hold Mfg. Co.**, Lansing, Mich., has developed a stratosphere chamber operating between plus 200 deg. F. and minus 75 deg. F., with an internal pressure variation from ambient at the location of the unit to 3 in. of mercury absolute. Both pressure and temperature variations are controllable throughout their ranges. The unit, which uses Freon-12 as refrigerant, has an interior chamber volume of approximately 186 cu.ft. Humidity control is from 25 to 95 percent, relative to all temperatures above plus 40 deg. F., or at a fixed bottom temperature of plus 32 deg. F. Heating equipment is composed of strip heaters arranged so that the forced convection circulates air during the



heat cycle. Three indicators are provided for continuous recording of temperature, pressures and humidity. Twelve mechanical connector shafts through the outer shell project inside the liner, permitting attachment of flexible or angular rigid shaft or small belt drive. Eighteen electrical connections are also provided.—AVIATION, *November,* 1942.

33

Compressed Wood Mallet

Hardness and durability of wood is increased through a patented chemical and compression process employed in manufacturing the Tornado Prestwood Mallets of the **Breur Electric Mfg. Co.**, 5100 N. Ravenswood Ave., Chicago, Ill. The new mallets—in three sizes and weights—can be produced in quantity and are available on short notice without priority.—AVIATION, *November,* 1942.

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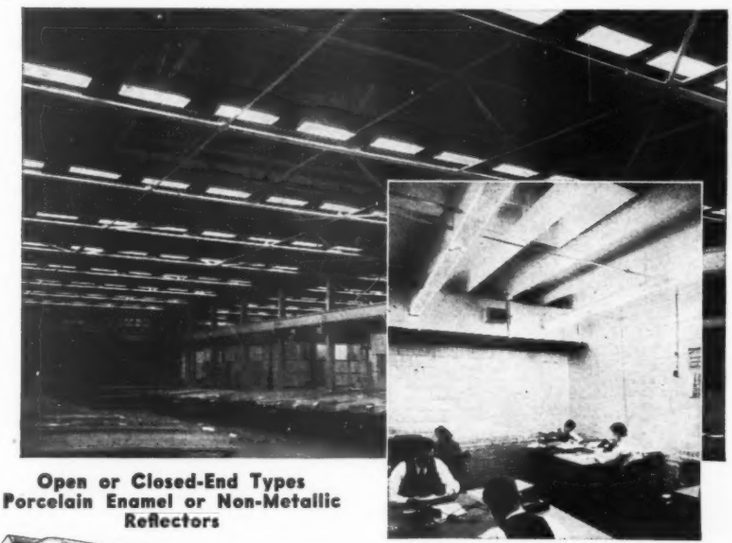
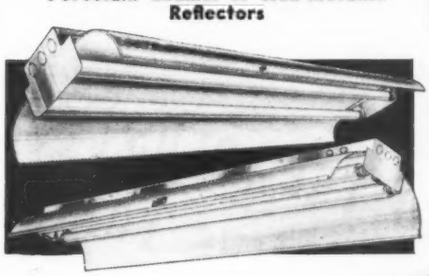


Open or Closed-End Types
Porcelain Enamel or Non-Metallic Reflectors



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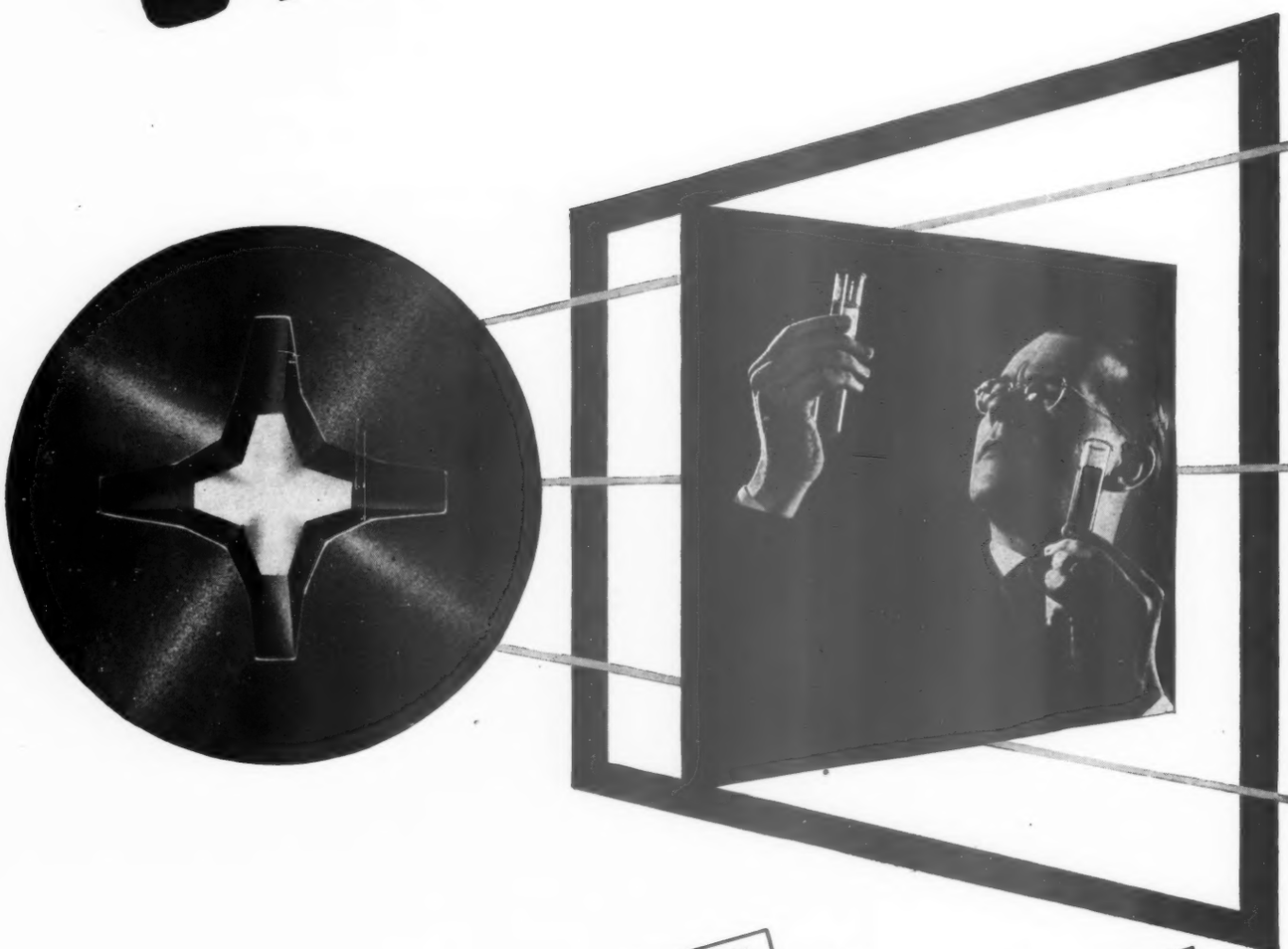


AMERICAN PRODUCED THE PLUS ...
THE PLUS IS PRODUCING FOR AMERICA

More and more leading firms write "American PLUS" in front of "Phillips" on their orders for recessed head screws.

Boeing selects American PLUS Phillips Screws

1st American Plus

American Screw Company engineers were *first* to perfect the Phillips recessed head for mass production. Their accumulated store of experience on hundreds of assembly lines . . . *added* to the well-known advantages of Phillips Screws . . . has helped many manufacturers get the most from man-hours and material in a war-critical time.

2nd American Plus

American Screw Company's continuous research into *metals and methods* . . . in its large chemical and metallurgical laboratories . . . not only assures the 100% reliability of American PLUS Phillips products, but also assures our customers of benefiting from the newest, proven advances in assembly methods and fastening devices.

American PLUS Phillips Screws in Northrop aircraft.

3rd American Plus

Inspection methods second to none — including piece inspection along a specially-developed conveyor line — insure full quality, full count in every shipment of American PLUS Phillips Screws.

You, too, like so many other leading producers, will find it worthwhile to standardize on American PLUS Phillips Screws. In addition to engineering aid, laboratory facilities and inspection methods, you will find extra value from the viewpoint of service, in the dependable delivery of American Screw Company products, stocked by an ever-increasing number of mill supply houses.

Lockheed writes "American PLUS" in front of "Phillips" on its orders for recessed head screws.

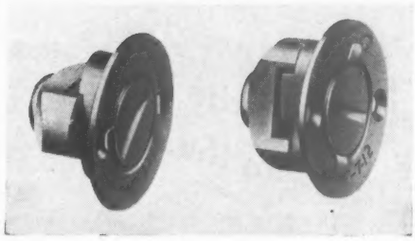
AMERICAN SCREW COMPANY

Providence, R. I.
Chicago, Ill., 589 E. Illinois St.
Detroit, Mich., 4-258 General Motors Bldg.

Wood Screws • Machine Screws • Sheet Metal Screws • Stove Bolts

34

Springless Cowl Fastener



A new type cowl fastener that has received Army Air Forces approval is announced by the **Nigg Engineering Co.**, Covina, Calif., and one series, the 7, is in production. Tooling up for another series, the 5, is in progress. The new fastener is unlike other devices in that it is not dependent upon springs but locks and unlocks by means of a screw action which produces any desired amount of tension. This variation accommodates a wide variety of sheet thicknesses, thereby reducing the number of sizes necessary to stock. Developed in collaboration with the engineering departments of several of the major aircraft companies, the Nigg fastener will stand tension loads of 1,600 lb., approximately 50 percent more than AN specifications, and shear loads up to 2,700 lb., or nearly 250 percent in excess of AN requirements. It is locked or unlocked readily with a screw driver and the position of the locking member of the stud is shown by an indicator.—AVIATION, *November*, 1942.

RYERSON

Specialized skill and experience built up in 100 years of steel-service to American Industry — vast tonnages of steel which move steadily through ten great Ryerson plants into war production — are at aviation's command.

For example, recently eighty seven bombers were held up awaiting delivery of 2⅜" rounds of WD-X4130. A Ryerson Steel-Service man was called at his home on a Sunday evening. Within a matter of minutes, Ryerson stocks in ten cities were being checked. All were temporarily out of the desperately needed bars—all but one.

A shipment of 2⅜" WD-X4130 rounds was just arriving at one of the Ryerson plants. The car was immediately opened and the same evening the steel was on its way to the airplane builder. A production bottleneck was broken.

When steel is needed in a hurry —and it often *is*, under pressure of war production — *call Ryerson!* If the required steel is to be had anywhere, Ryerson can, and will supply it!

JOSEPH T. RYERSON & SON, INC.
Chicago, Milwaukee, St. Louis, Cincinnati, Detroit, Cleveland, Buffalo, Boston, Philadelphia, Jersey City

35

Copying Machine

Photo Reproducing Equipment Co., Chatham, N. J., has introduced a line of reproducing machines known as Trucopy-phote designed to make facsimile reproductions of anything written, printed, drawn or photographed in actual size. A single copy can be made in about 13 min., with additional copies requiring about 1 min. more each. Both a.c. and d.c. electric and portable battery models are available. No focusing is necessary, and darkroom equipment is not required.—AVIATION, *November*, 1942.

36

Fairlead Guide Block

A new Speed-Align adjustable fairlead guide block that is universal for any angle of cable is being introduced by **Tinnerman Products, Inc.**, 2070 Fulton Road, Cleveland, Ohio. The new block is composed of a three-piece macerated phenolic plastic guide housed between an aluminum base and a special spring steel speed nut, and accom-

(*Turn to page* 177)

"TRIAL-TEST" POR-OS-WAY

the new, precision grinding wheel!

IT DELIVERS

2 TO 5 TIMES MORE PRODUCTION PER MAN PER MACHINE

LET USERS TELL THE STORY—

STER AND COOLER—"Cut so much ter and cooler than other wheels that veral department heads were called in witness the operation." (Surface nding small discs.)

0% BETTER PRODUCTION—"Gave 0% better production than competitor eel. Held a true edge in grinding a mplete gear cutter with no burn whatever. Free, cool cutting without dress-g. Good finish." (Grinding high-speed tter tool steel on Le Blond grinder at 50 R.P.M.)

CH EXCELLENT RESULTS—"As head department, would like to change over grinding to Por-os-way wheels as I ve had such excellent results."

0% BETTER PRODUCTION—"Very ccessful; gave 350% better production." rinding Stellite "J" cutter heads on ncinnati No. 2 tool and cutter grind-at 5735 R.P.M.)

OUTSTANDING GRINDING QUALITIES—"Outstanding grinding qualities. Wheel wore but ¼" on 50 pcs. ground. Edge held up." (Grinding shafts in gauges at 3200 R.P.M., removing .005" stock.)

NO LOADING, NO BURN—"Cut freely, did not load and cut hardest steel without any trace of burn. Obtained at least 300% better production." (Facing tool steel gears SAE 41-50 at 3460 R.P.M.)

HELD EDGE WITHOUT DRESSING—"Gave 50% better production than competitor. Held edge without dressing. Ground 4942 pcs.—average 353 pcs. per hour." (Grinding hardened steel bushings on B & S.)

25% INCREASE IN WHEEL LIFE—"Enclosed find order for Por-os-way. Trials very satisfactory. Reduction of 40% grinding time. 25% increase in wheel life".

POR-OS-WAY* 8 WAYS BETTER

1. 2 to 5 times faster stock removal. Takes deeper cuts, or usual cuts at faster feeds.
2. Holds its corners. Requires only minimum dressing.
3. Does its job at the lowest possible cost.
4. Equal or better wheel life.
5. Cool action structure.
6. Practically ends burning.
7. One man, one machine can do the work of 2 to 5.
8. Free cutting. Resists "loading" of soft materials.

See the trend to Por-os-way—introduced formally in Fortune Magazine, February, 1942.

*T. M. Reg. U. S. Pat. Off.
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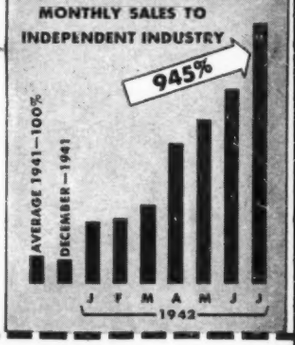
POR-OS-WAY
MONTHLY SALES TO INDEPENDENT INDUSTRY



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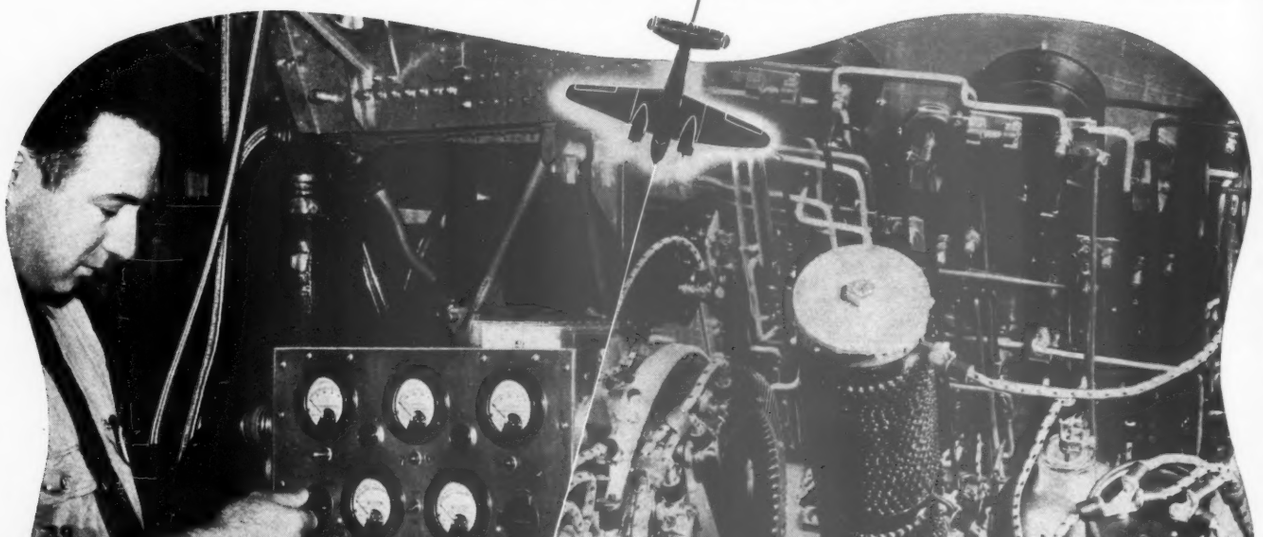
The Western Gateway to Valley Forge

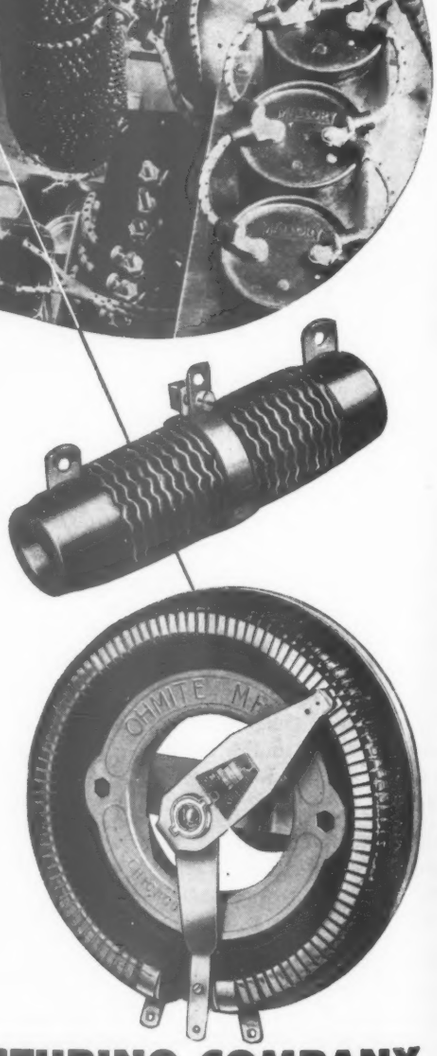
OHMITE Rheostats, Resistors in Electrical Analyzer for Aircraft



Analyzer Saves TIME for Republic Aircraft

The electrical analyzer, devised in the testing laboratories of the Republic Aviation Corp., was designed primarily to speed up aircraft testing and locate trouble without disconnecting any wiring. It also enables making adjustments on all electrical equipment prior to final assembly, for it is able to duplicate any missing circuits or loads. It also enables a direct analysis of any error in wiring assembly, indicating the exact location of circuits in error. Wide variation of power output makes it adaptable to any type of service or testing.

The use of Ohmite resistance units in this aircraft electrical analyzer is another indication of how Ohmite products help speed war production—how they help test planes as well as fly them.



Write on company letterhead for helpful 96-page Industrial Catalog and Engineering Manual No. 40.

OHMITE MANUFACTURING COMPANY
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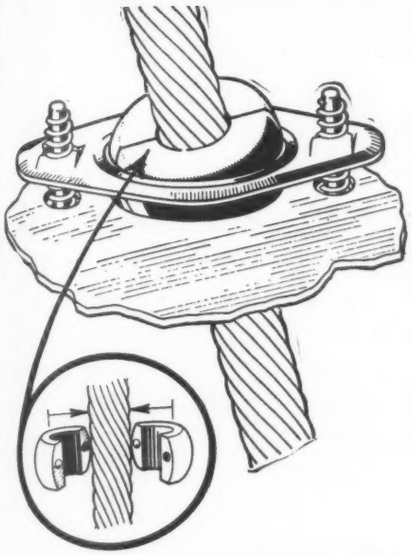


modates cables up to 3/16 in. diameter. For a 29/32 in. diameter a similar unit, except for the aluminum base, is used. For cables or control rods from 1/16 to ½ in. in diameter a two-piece graphitized phenolic plastic guide is available. Natural graphite is impregnated into the plastic so that the guide is self lubricating.—AVIATION, *November,* 1942.

37

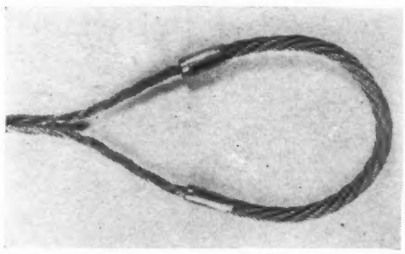
Infra-Red Heat Lamps

A new line, embracing six clear types, three ruby types and four reflector types of infra-red heat lamps designed in keeping with WPB limitations, has just been announced by the **Birdseye Division** of the **Wabash Appliance Corp.**, 335 Carroll St., Brooklyn, N. Y. All feature the M-type tungsten filament for uniform heat distribution and have their bases reinforced with asbestos-lined mechanical straps to withstand the high temperatures of tunnel installations. The reflector types have built-in reflector linings of pure silver sealed inside the bulbs for protection against dimming and tarnishing by fumes or dirt. Average burning life of all the lamps is said to be in excess of 6,000 hr.—AVIATION, *November,* 1942.

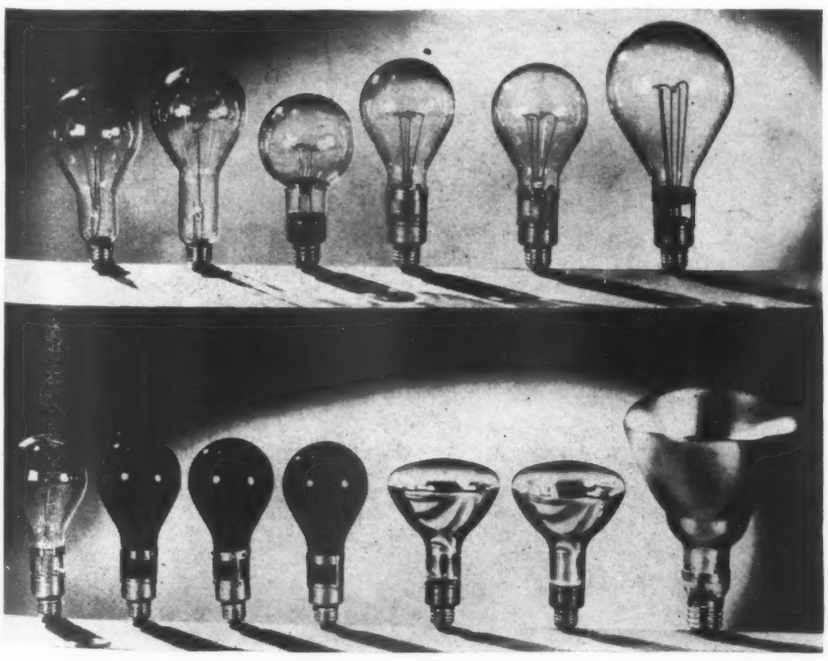
38

Wire Rope Sling

A new wire rope sling called Flatweave has been developed by **John A. Roebling's Sons Co.**, Trenton, N. J., to meet the need for light, flexible, nonspiralling slings to handle light and medium loads. These slings have a flat



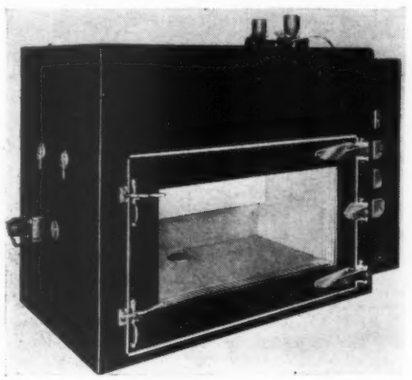
bearing surface which is said to allow an even pressure on each of the six ropes which comprise the sling. Two pairs of ropes are laid in opposite directions. These are united into a finished sling unit by two single tie ropes which alternately pass back and forth around one pair and then the other in a spiral figure 8. This method is said to eliminate scissors or shearing action between the various ropes. Compact steel sleeves are compressed over all rope ends, thus permanently securing them.—AVIATION, *November,* 1942.



39

Instrument Test Chamber

American Coils, Inc., Newark, N. J., has developed a new chamber for testing instruments in operating temperatures ranging from minus 55 deg. C. to plus 70 deg. C. It includes apparatus for mechanical refrigeration and electric heating. Observation is provided by an inner door with five glasses sealed and dehydrated against passage of moisture, with the visible opening measuring 21½x46 in. The all-steel cabinet occupies space 83 in. wide by 56½



high by 42 deep, with usable interior measuring 59 in. wide by 28 high by 30 deep, with an interior cubic content of 28.7 ft.—AVIATION, *November,* 1942.

40

Hair Protector

To protect women employees working with moving machinery, **Standard Safety Equipment Co.**, 232 W. Ontario St., Chicago, Ill., has developed three styles of StaSafe Hairgards. Goggles may easily be put on or removed, and the mesh of the guard allows enough ventilation to keep the worker's head cool.—AVIATION, *November,* 1942.

41

Propeller Balancing Way

Anderson Bros. Mfg. Co., 1907 Kishwaukee St., Rockford, Ill., has introduced a new Static Balancing Ways designed especially for aircraft propellers. Designed as a low-cost unit, it has been developed to make balancing ways available to many service stations which now do not have such equipment.

AVIATION SCHOOLS TRAIN WORKERS WITH CP TOOLS

↑ **STUDENT IN CALIFORNIA** aviation school tightening elastic stop nuts with a CP 337-RAF Pneumatic Wrench (impact type). Latest CP aviation tool development, the CP 337-RS (straight-handle model), is only 5½" long, weighs only 2 pounds. For hard-to-get-at places there are 45° and 90° angle drive models of this new wrench.

SELECT CP LINE BECAUSE MOST WIDELY USED IN INDUSTRY

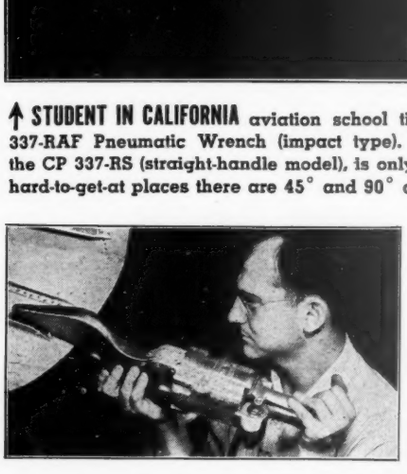
New Tools Keep Schools Abreast of Industry

NEW YORK (CP) — Realizing the CP line of airplane tools is the largest and most widely used in the industry, aviation schools throughout the country are training their students with CP pneumatic riveters, drills, screw drivers, impact type wrenches and special-purpose aviation tools. The advantage of this policy is obvious: graduates entering industry get under way with the minimum of plant instruction because they have been schooled with the very tools which they are called upon to use.

Appreciating the importance of student training as a factor in the achievement of the airplane production goal, Chicago Pneumatic Tool Company makes the latest tool developments available to schools as rapidly as they are released to industry.

CHICAGO PNEUMATIC TOOL COMPANY

General Offices: 8 E. 44th St., New York, N. Y.



↑ **DRIVING 5/32" RIVETS** without bucking up — with a CP tool that is speeding production in practically every airplane plant: CP 351 Squeeze Riveter with 5" alligator type jaw.

TIGHTENING PHILLIPS' HEAD SCREWS with another CP tool — the CP 301 Pneumatic Reversible screw driver; loosens as well as tightens screws. ↓

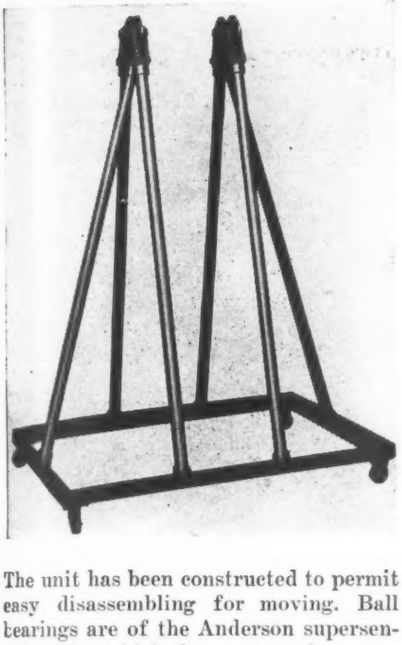
↑ **LEARNING TO DIMPLE** quickly with a CP 214 Riveter-Dimpler. Automatic head insures uniform pressure regardless of line fluctuation; capacity, ⅛" Dural rivet.

CHICAGO PNEUMATIC

AVIATION TOOLS

ALSO: Air Compressors, Electric Tools, Hydraulic Aviation Accessories, Diesel Engines, Rock Drills

RIVETERS
RECIPROCATING
COMPRESSION
HYDRAULIC
DRILLS
GRINDERS
SCREW DRIVERS
NUT RUNNERS
PLANISHING IRONS



The unit has been constructed to permit easy disassembling for moving. Ball bearings are of the Anderson supersensitive type which the company has manufactured for 25 years.—AVIATION, *November,* 1942.

42

Arc Welding Electrode

Designed primarily for use in welding aircraft tubing and assemblies, a new electric arc welding electrode called the Harcraft has been added to the line manufactured by the **Harnischfeger Corp.**, Milwaukee, Wis. The new electrodes will be supplied in a complete range of sizes in standard cut lengths. Physical and chemical properties and welding procedures will be supplied on request.—AVIATION, *November,* 1942.

43

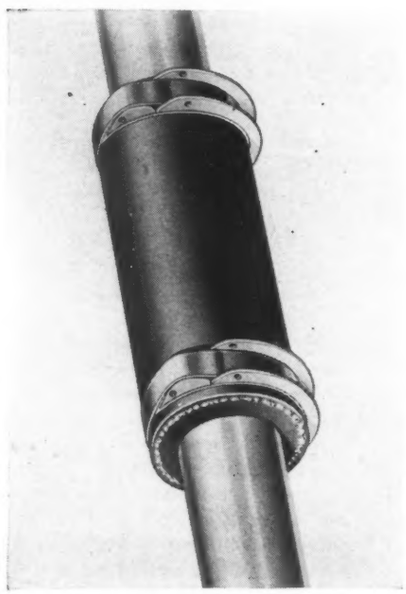
Arc Etching Machine

An electric arc etching process for permanent identification of parts, tools, etc., has been developed by **George Gorton Machine Co.**, Racine, Wis. Known as the Spitfire Model A-E, the machine employs the Gorton extension arm design to reach inaccessible places such as cylinder interiors, cavities or both sides of vee-blocks. Etching depth is variable by one dial control from .0001 to .003 in.; width is variable by diameter of electrode used from .075 to .015 in. Characters can be varied in height from 1/32 in. up. Operating on 110-120 v., 60 cycles a.c. only, etching voltage is stepped down and is variable from 3 to 9 v. Dimensions are as follows: vertical capacity, spindle to table: with screw 0 to 10 in., without screw 0 to 13¾ in.; normal spindle distance, spindle to column face: for 3:1 fixed ratio, 9½ in.; for 6:1 fixed ratio, 6½ in.; size of work table, 8 to 12 in., with ⅜ in. milled longitudinal T-slot at center, four 7/16 in. diagonal cored slots. The entire machine occupies floor space of 31x29 in. and is 44 in. high.—AVIATION, *November,* 1942.

44

New Type Hose Clamp

A self-locking, wrap-around hose clamp that requires no bolts, nuts, binding screws or pivots, and can be installed by hand, without tools, is announced by **Huntington Precision Products**, Huntington, W. Va., a division of Adel Precision Products Corp. Uniformity of pressure to prevent bulges,



bends or excessive stress are advantages claimed for the new clamp. It is made of stainless steel and has provision for safety-wiring, but laboratory tests indicate that such wiring is unnecessary. It may be used over and over without fracture or loss of time.—AVIATION, *November,* 1942.

45

Circular Saw

A new continuous rim saw with inserted sections rather than inserted teeth which can be readily sharpened on an automatic grinder, has been introduced by **Henry Disston & Sons, Inc.**, 1600 Arch St., Philadelphia, Pa. The inserted section design is said to permit a thinner blade and cutting edge than is customary with saws having individual inserted teeth, and transfers the cutting load from each insert directly to the blade approximately at right angles to the resultant force. The full thickness of the blade extends to the extreme diameter, a feature which is said to give maximum support to the inserts and at the same time permitting long life. The inserts are quickly and easily replaced should they be damaged by accident. Such work can thus be done in the user's own plant or a nearby saw repair shop. The new unit

What are you doing about
PLASTICS ?

NOW is the time to learn about plastics—so you may take advantage of this industry's important new developments—so you can apply to your duties or products the *last word* in plastics. The Plastics Institute is already rendering a valuable service to far-sighted men—in the three activities listed below—send for full information on the phase that interests you most.

SPARE TIME TRAINING
For spare time education, the Basic Lesson Assignments bring you clear definitions of the different types of plastic materials. The machinery and methods of the plastics industry are clearly illustrated and described. Technical details are explained fully.

STUDY-FORUMS
The Plastics Institute conducts Study-Forums in many industrial centers for the convenience of men interested in more complete and practical training in plastics. Each Forum is conducted by a recognized authority. Write for address nearest Study-Forum.

RESIDENT COURSE
Designed for men who need a complete, comprehensive plastics education, including shop and laboratory training, the Plastics Institute offers a comprehensive Plastics Engineering Course. This one year course is available only at the Institute in Los Angeles—and classes are restricted.

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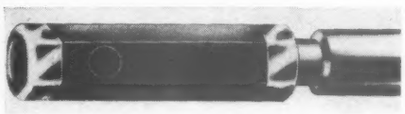
can be operated at speeds up to 5,000 rpm.—AVIATION, *November*, 1942.

46

Plastic Gage Handles

To circumvent the shortage of metals, **Federal Tool Corp.**, 405 N. Leavitt St., Chicago, Ill., has developed a line of plastic gage handles, accurately made to standard dimensions accepted throughout industry. As the plastic ma-



terial is lighter than metal, a lighter touch is possible and the possibility of fatigue from long use is said to be reduced. They are marked with the same lettering stamps used for marking metal handles.—AVIATION, *November*, 1942.

47

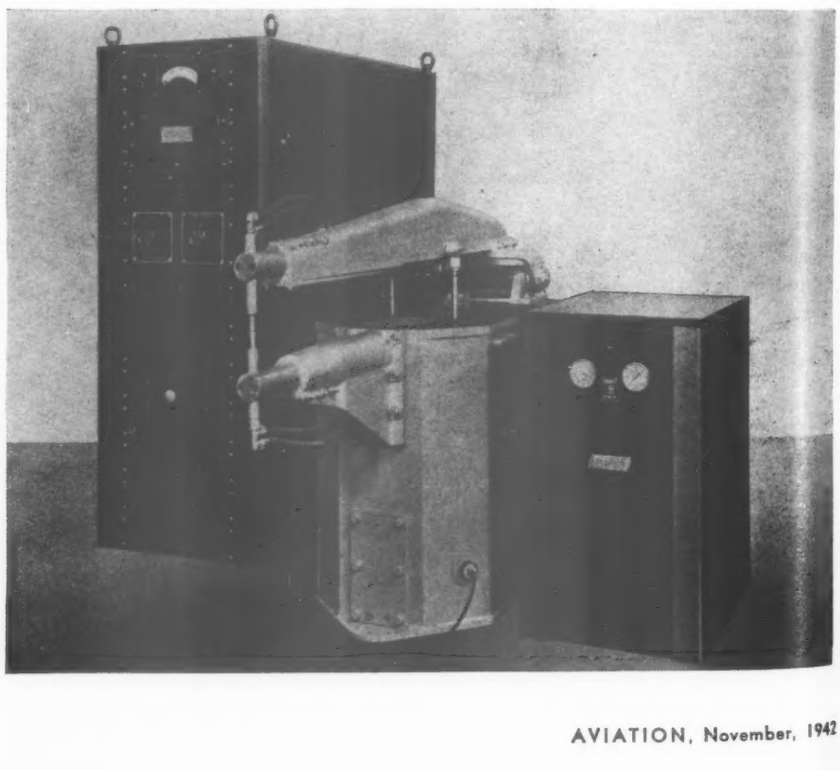
Rocker Arm Welder

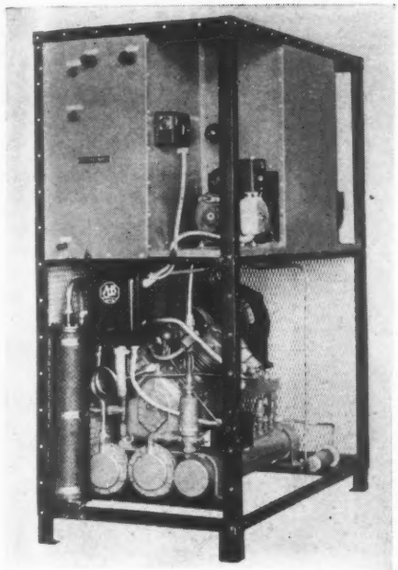
A new line of rocker arm welders for stored energy resistance welding has been announced by **Progressive Welder Co.**, E. Outer Drive, Detroit, Mich. The new units are available with the Revers-O-Charge capacitor discharge controls as well as the Frostrode refrigerating units for below-freezing welding. Designed for aluminum welding, the new machine has a retractable stroke of 9 to 12 in., depending on throat depth. Retraction is accomplished by a fractional hp. motor driving a lead screw. The welding stroke has a range up to 3 in. Differential action double air cylinders are used for the welding stroke, the cylinder for return stroke being smaller than that for the pressure stroke. As a result, air pressure can be maintained continuously in the return stroke cylinder to insure prompt point opening after completion of the weld. Point dressing is accomplished by exhausting the return stroke of the air cylinder by means of a three-way valve on the side of the machine, an exclusive feature.—AVIATION, *November*, 1942.

48

Spot Welding Tip Cooler

A new self-contained cooling apparatus which circulates a special non-corrosive, non-precipitating solution through welding tips of a spot welder is now being produced by **Fairbanks, Morse & Co.**, 600 S. Michigan Ave., Chicago, Ill. A F-M built recirculating pump, operating continuously with the compressor, circulates Freon-12 refrigerant through the evaporator for high heat transfer. An F-M built turbine-type pump circulates the special solution of high specific heat characteristics from the unit to the welding tips and back to the unit. A thermostatically controlled, four-cylinder, vee-type compressor, as well as the pump, is equipped with high pressure cutout. The



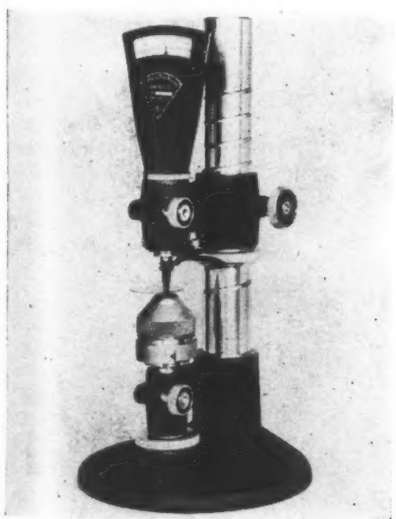


entire unit is 55 in. high, and occupies 25x44 in. floor space.—AVIATION, *November,* 1942.

49

Ball Measuring Anvil

The **George Scheer Co.**, 128 Lafayette St., New York, N. Y., has just developed a ball measuring anvil for use on the Scheer Comparitol designed to speed and simplify measurement of thin work such as crystals, laminations, shims and extremely small gages and other flat work. With the ball anvil the



work is placed between the flat feeler point and the round ball surface and dependable results are said to be obtained regardless of which part of the thin piece under inspection is being measured. Another feature is said to be that flatness or parallelism of long thin pieces in all positions and on all parts of the work can be checked.—AVIATION, *November,* 1942.

YOU CAN REDUCE THIS "AID AND COMFORT" TO THE ENEMY

Startling figures? . . . Then add to them the 19,200 deaths from plant accidents during the same period and you will understand why the Axis war lords studied this report with gloating satisfaction.

W.P.B. RECOMMENDS GOOD LIGHTING TO REDUCE ACCIDENTS

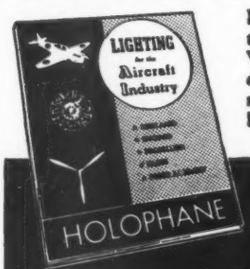
The following appears on page one of the publication "PLANT EFFICIENCY", issued by the War Production Board:

"Striking examples of close relationship between the quality of lighting and accident frequency are not difficult to find . . . So many factors are involved in industrial accidents that it is practically impossible to say what percentage is caused by poor lighting. It is reasonable to assume, however, that with the quicker perception and greater clarity of vision which good lighting makes possible, accident hazards will be recognized faster and more clearly, with correspondingly increased chances of avoiding them . . ."

HOLOPHANE HAS PIONEERED IN GOOD LIGHTING—SINCE 1898

For more than two generations, this organization has concentrated on the advancement of illumination in American institutions. All through these years, Holophane engineers, in the field and in the drafting rooms, have played an important role in the development of PLANNED LIGHTING for industry . . . Since Pearl Harbor they have shown hundreds of plants the way to faster, smoother war production through lighting engineered to meet specific manufacturing needs and working conditions . . . The Holophane principle of light control calls for prismatic glass units, which require a minimum of critical materials. They provide efficient light for essential working areas with assured savings in man hours, electric power and maintenance costs.

FOR SAFE, EFFICIENT ILLUMINATION, CONSULT HOLOPHANE ENGINEERS



Plant management is urged to investigate the signal advantages that Holophane lighting can bring to the plant today. Without charge, the Holophane engineering department offers consultation and recommendation for the most effective, economical illumination . . . Write for the latest Holophane bulletin "Lighting for Aircraft Industry", available to executives.

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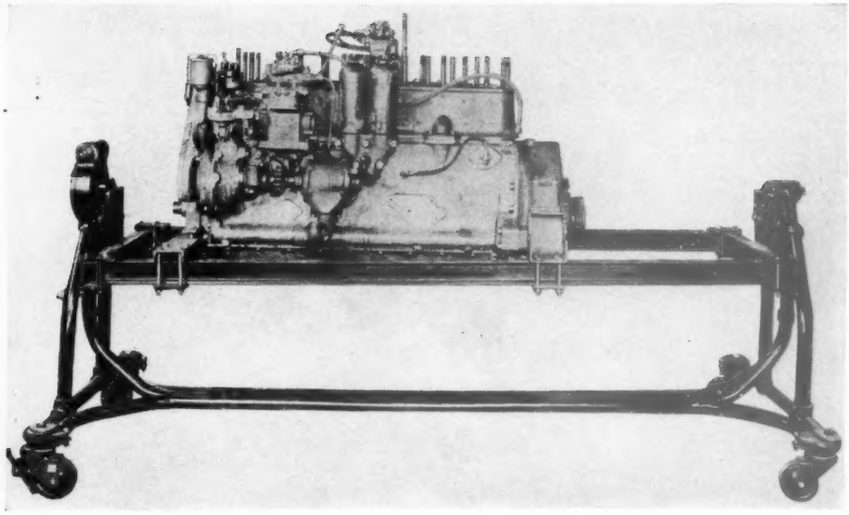


50

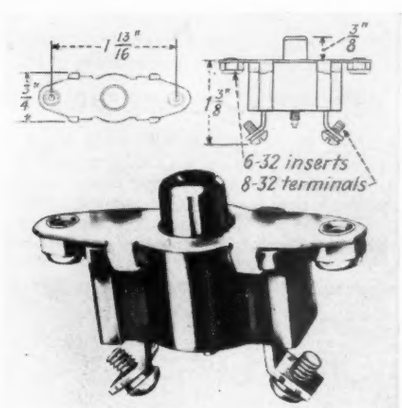
Engine Rebuilding Stand

A welded tube and angle iron engine rebuilding stand which can be disassembled by removal of but eight bolts has been put in production by **Motor Rebuilding Specialties**, 2634 S. Michigan, Ave., Chicago, Ill. It can be folded and nested into about one-fifth the space of an erected unit. A 48 to 1 gear ratio permits easy rotation of the cradle to any convenient operating position. The stands are available for both radial and in-line engines weighing up to 3,000 lb.—AVIATION, *November,* 1942.

51

Circuit Breaker

Designed for aircraft and other wartime installations, the new Klixon PSM circuit breaker announced by **Spencer Thermostat Co.**, Attleboro, Mass., has the same mounting dimensions as the standard AN mechanical toggle switches. It is a disk-operated device with manual reset which gives shockproof and vibration-proof protection against harmful overloads. Self-locking inserts for mounting are standard, and the breakers can be had either with plain or luminous-tipped reset button.—AVIATION, *November,* 1942.



52

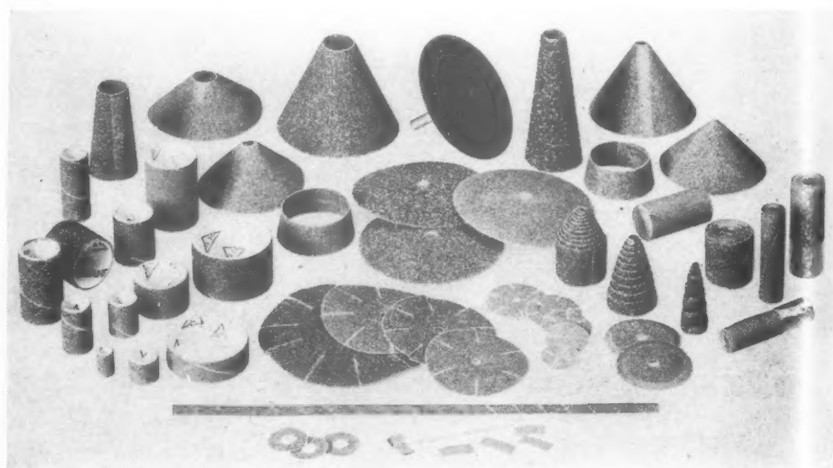
Welding Flux

A free-flowing flux for gas welding of aluminum and aluminum alloys is now being manufactured, under the trade name Flo-Ez-Flux, by **Park Stewart**, 1008 Carbis St., Worthington, Pa. Said to be especially adapted for aircraft work, the flux is being used to gas weld either wrought, cast or high tensile aluminum or aluminum alloys of any size or shape where welding is possible.—AVIATION, *November,* 1942.

53

Abrasive Cloth Specialties

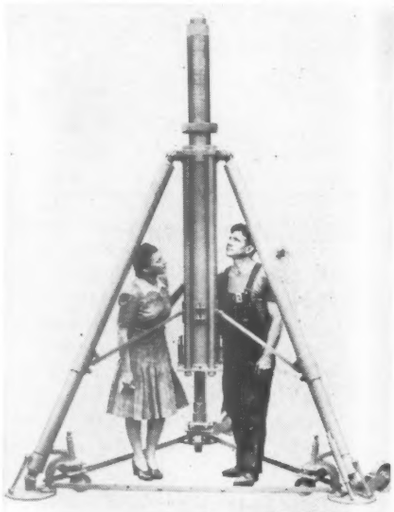
A line of abrasive cloth "Gadgets" has been developed by **Behr-Manning**, Troy, N. Y., for use on portable tools, punch presses, etc. Designed to do in seconds what would require minutes by hand operation, the Metalite (aluminum oxide) Cloth abrasives have been built to use in inaccessible places not ordinarily adaptable to mechanical sanding.—AVIATION, *November,* 1942.



54

New Hydraulic Jack

Designed for use at fields and bases where airplanes of various types and sizes are serviced, a new, variable-height hydraulic aviation jack, is now being manufactured by the **Malabar Machine Co.**, 5722 Santa Fe Ave., Los Angeles, Calif. Quickly adjustable length of tripod legs permit variations in height from 60 to 124 in. with a 48-in. lift. The ram is equipped with a patented locking nut which screws down tight against collar of tripod to prevent settling of load. The model shown



★ *Woodworth employs a nearly equal number of men and women. By Mid-Winter, personnel records will show 80% women and 20% men.*

TO N. A. WOODWORTH MEN AND WOMEN FOR *"Outstanding War Work"*

Men and women of N. A. Woodworth Company have received the only military decoration given to civilians, the Army-Navy "E" Award. ★ ★ ★ This signal honor has been accepted with sober consideration of the greater responsibilities it demands. Having publicly acknowledged our production accomplishments, the Army and Navy expect us to maintain and even surpass past efforts as America's Armed Forces step-up the military pace against Axis aggression.

★ ★ ★ Mighty bombers, deadly fighter planes are impotent if integral engine parts fail to stand the stress of combat flying. In manufacturing over 100 highly precisioned engine parts, Woodworth employes keenly feel their responsibility in this country's war effort. ★ ★ ★ Management and labor are pledged and anxious to meet any new production goals and mechanical requirements set forth by the Army and Navy to always be worthy of the "E" Award.

N. A. WOODWORTH COMPANY

AIRCRAFT ENGINE PARTS • PRECISION TAPS • HEAT TREATING, PLATING • PRECISION GAGES

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NO FIRE HAZARD
Fuel will not burn even when subjected to open flame.
K
LOWER FUEL CONSUMPTION
Uses only 26.2 per cent as much fuel per hour as equivalent powered gasoline engine.
J
MORE POWER AT ALL SPEEDS
Flat torque curve keeps maximum power flowing at all operating speeds.
J
NO IGNITION SYSTEM
No sparks to cause fire, no radio interference, fewer parts.
10
DEPENDABLE OPERATION
First A.T.C. certificate for airplane use granted more than 10 years ago.
THE GUIBERSON
AMERICA'S ONLY RADIAL AIR-COOLED
DIESEL ENGINE
The same fundamentals that make the Guiberson high-speed radial diesel the engine to help win the battles of today on land, in the air and on the sea will win world leadership for America in the field of post-war transportation. No other engine of equivalent or lower weight per H.P. provides such dependable low-cost fire-safe power as the Guiberson radial diesel. Backed by more than 13 years of engineering development—it's the engine with the power to win.
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SAFE THAN SORRY BETTER BE GUIBERSON
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★ THE GUIBERSON CORPORATION
Aircraft and Heater Division

has a capacity of 25 tons vertically and 7,500 lb. horizontally. Other models of capacities from five tons up are also in production.—AVIATION, *November,* 1942.

55

Three-Way Vise

Universal Vise & Tool Co., Parma, Mich., announces a three-way vise to hold work rigidly for milling, drilling, boring, reaming, grinding, shaping, die sinking, and other operations. The

double swivel cradles—each allowing 90 deg. adjustment—over a full swiveling base—allowing 360 deg. rotation—provide three separate motions, individually adjustable and lockable. The wedge locks are 2,000 lb. torque tested. Jaw opening is 5 in. Weight of the unit is 70 lb.—AVIATION, *November,* 1942.

56

Duplicator

Available without priorities is the new Automatic Rotary Gelatin Duplicator designated Model R5, recently developed by **Ditto, Inc.**, Harrison at Oakley Blvd., Chicago, Ill. It is made in both automatic and hand-fed types designed to deliver, from original writing, typing or drawing, up to 150 copies —70 per min. on automatic feed machine, 40 per min. on hand feed machine, and will reproduce eight colors simultaneously.—AVIATION, *November,* 1942.

57

Communication System

A new combination of standard features of the Executone system is incorporated in the Executive-Monitor communication system produced by **Executone, Inc.**, 415 Lexington Ave., New York, N. Y., whereby two or more master stations can be connected with 19 remote stations. The Executive and Monitor stations can talk to each other, or either can carry on two-way amplified voice conversations with remote desk or trumpet-type substations in outlying departments. An interceptor control feature enables an assistant at the monitor station to intercept all incoming calls originating at remote stations. —AVIATION, *November,* 1942.

58

"Slide Rule" Metal Specifier

A new picket-size slide chart which provides a blueprint of American standard dimensions and data for all sizes of elementary parts such as nuts, bolts, plain and lock washers, keys, pipe threads and sizes of tap drills is being made under the name Elemoto slide chart, by **Elemoto Sales**, Teaneck, N. J. Specifications can be obtained with one movement of the slide, which also gives dimensions of countersunk, fillister, round and hexagon heads. In addition the slide carries tabulations on decimal equivalents sheet and plate gages, twist drill and steel wire gages and conversion figures between millimeters and inches.—AVIATION, *November,* 1942.

59

Welder's Cover Glass

A new cover glass for welder's hoods and goggles called Klearsite is being marketed by **Carter-Lockard Co.**, 225 W. 11th St., Los Angeles, Calif. By utilizing a new technique, it is said

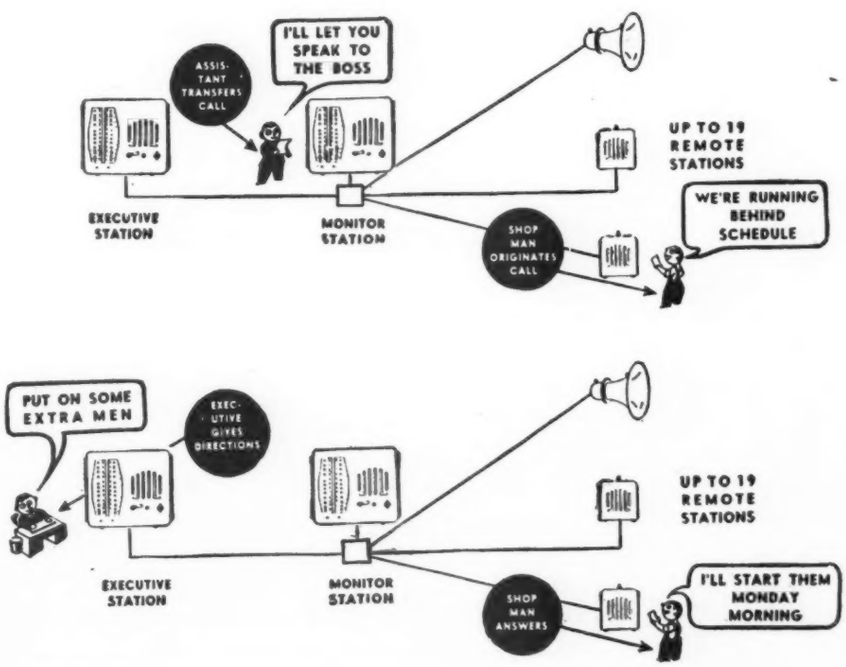
that the new material will stay clear for more than 100 hours of welding time, repelling sparks and molten metal

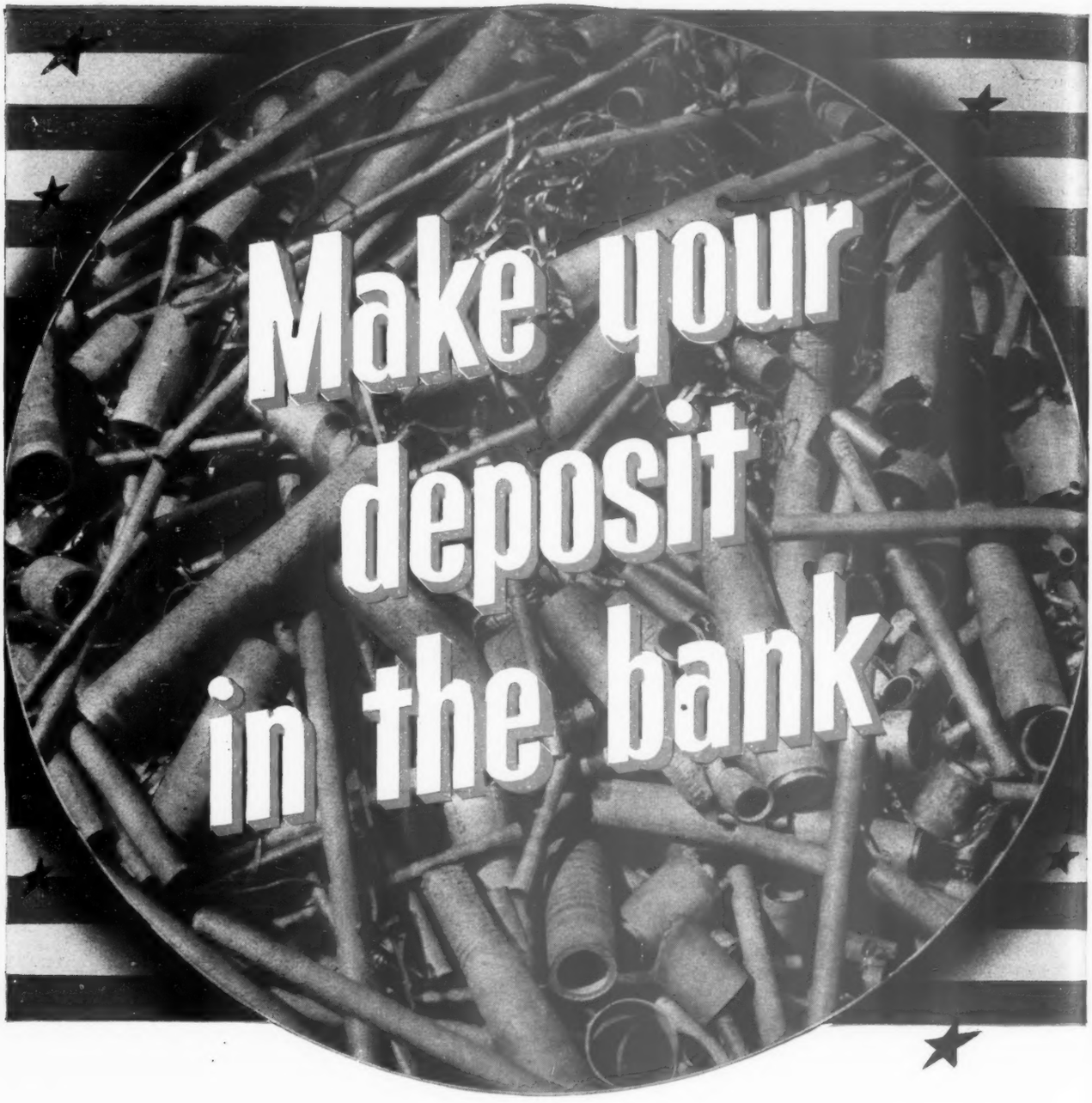
with which it comes in contact. The "dill berries" which stick to ordinary glass are said to slide off the new material.—AVIATION, *November,* 1942.

60

Lift Trucks

A new line of 3,000-lb. capacity lift trucks of tilting fork type, telescopic and non-telescopic, has been introduced by **Lewis-Shepard Co.**, 123 Walnut St., Watertown, Mass. Available with either electric or gas power units, the trucks have low-slung, one piece, ribbed and reinforced single casting frames.—AVIATION, *November,* 1942.





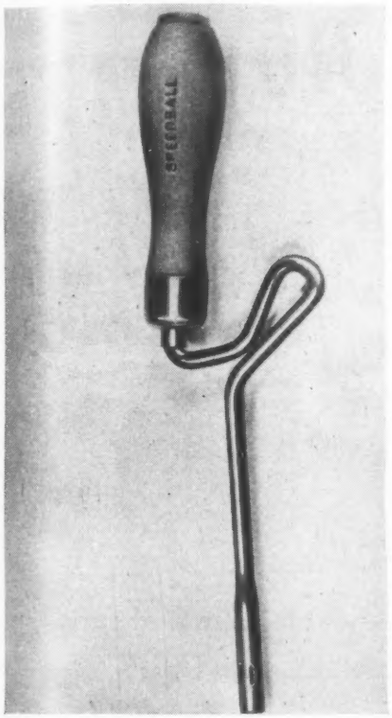
SCRAP piles are much more than mere collections of trim ends, cuttings, useless machines, parts and junk these days. They're vital national resoures—*American Treasuries*, in fact, in this critical year; because the nation's steel producers will need several million more tons of scrap in 1942 than ever before, if the demands of war production are to be met. • How much can *you* contribute? Not just the usual scrap flow from your operations, but *all* the idle metal around your buildings and yards that it isn't absolutely essential to keep. Your deposit in the scrap bank will pay dividends all over the world—*make it a real one!*

Allegheny Ludlum
STEEL CORPORATION
GENERAL OFFICES: PITTSBURGH, PENNSYLVANIA

61

High Speed Driving Tool

Recently announced by the **Aero Tool Co.**, Burbank, Calif., is a new high speed ball bearing driving tool known as the Aero Tool Speedball Driver. According to the manufacturer, assembly jobs can be greatly speeded by the



tool, which drives screws, countersinks, or removes burrs. Replaceable tips, conveniently stored in the recessed handles, give the tool a wide variety of uses. It can be supplied in several shapes for special work with tips for Phillips screws, slotted-head screws, set screws, or for burring and countersinking jobs. A tapered shank on the tip allows for easy removal but will not permit the tip to turn in the tool.—AVIATION, *November,* 1942.

62

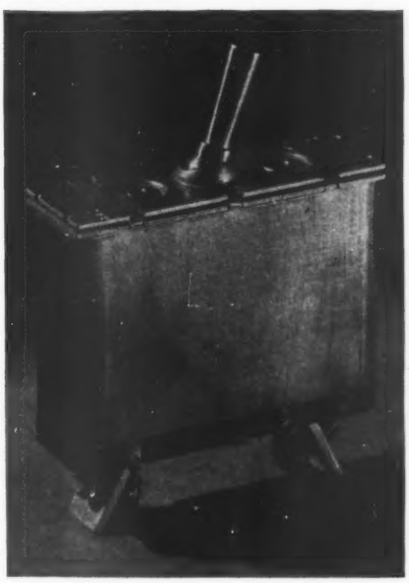
Air Motors

Smith-Johnson Corp., 623 E. 12th St., Los Angeles, Calif., has developed a line of air motors with universal integral valves, for use where reciprocating motion is required. As auxiliaries to machine tools, the motors are said to save time in opening and closing vises and holding fixtures, operating clutches and latches, moving work pieces and tools to and from each other and similar operations. The motors, named Senacon, can also be used as prime movers for supplying fractional horsepower in such operations as tube flaring, punching, broaching, stamping, die casting and bushing insertion. Dual exhaust ports provide for selective utilization of exhaust air blasts for ejecting work pieces, cleaning out chips and permitting adjustment of speed of one or both strokes. Available in standard models with stokes of 1½ in., 2½ in., 6 in. and 9 in., with other sizes ranging from 1 to 18 in. available on special order.—AVIATION, *November,* 1942.

63

Circuit Breaker

A new type ANC air circuit breaker designed for aircraft electrical systems using a direct current power supply of 28 v. or less has been announced by **Westinghouse Electrical & Mfg. Co.**, Dept. 7-N-20, East Pittsburgh, Pa. The breaker affords both circuit operation and protection in one unit that can be installed in the same mounting space as the present toggle switch. It has a rating of from 5 to 50 amp. at 28 v., d.c., and a 1,500 amp. interrupting



capacity. The unit is manually operated with a 50 deg. swing of the handle from the off to on position.—AVIATION, *November,* 1942.

64

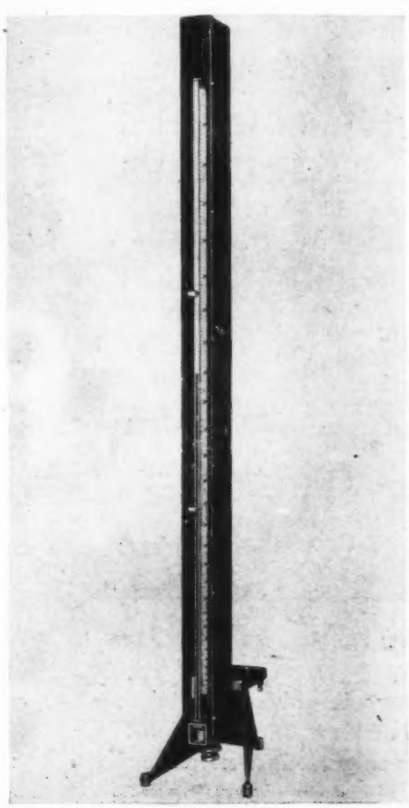
Direct Reading Manometer

A special well-type, direct reading manometer for testing aircraft instruments has been developed by the **Meriam Co.**, 1953 W. 112th St., Cleveland, Ohio. It has a flexible scale arrangement so that the single instrument can be used to test all aircraft instruments operating on the pressure or vacuum principle. The Model A-338 incorporates an eight-sided scale selector, permitting selection of proper scale for the particular instrument under test. All scales are adjustable to suit barometric conditions in any specific locality and are direct reading in miles-per-hour; knots; pounds; inches; millimeters, etc. The range is from 0 to 61 in. of mercury or water. An integral return well prevents loss of indicating fluid.—AVIATION, *November,* 1942.

65

Metal Etcher

The Ideal Commutator Dresser Co., 5146 Park Ave., Sycamore, Ill., announces a new electric etcher designed for permanent marking of anything made of steel, iron or their alloys. The new unit has 14 etching heats between 115 to 1,300 watts. A red lamp on front of the machine indicates when power is on and burns brighter as each higher heat is used. Depth of mark can also be controlled by speed of writing. Special heat radiating fins and alloy tip point are provided. Secondary cables have asbestos covering, work plate is 4x7 in., with ground clamp attachment, 115v., 50-60 cycle standard, weight, 32 lbs.—AVIATION, *November,* 1942.



★ ★ ★ EXTRA ★ ★

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First Contracts Cover Manufacture of Ailerons, Rudders and Elevators IN ALUMINUM

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Investigation of Lyon Facilities Invited

● Now—Lyon is equipped to produce aircraft parts. Facilities are available to work in sheet aluminum as well as steel. Workers for this new Lyon Aircraft Division have been specially trained in actual production by working in aircraft plants.

Aircraft parts in production include Ailerons, Rudders, Elevators, Vertical Fins and Stabilizers. Plant facilities are available for manufacturing additional aircraft parts, assemblies and subassemblies in aluminum or steel.

We invite your careful investigation of Lyon facilities as a de

pendable source of supply. Ou illustrated brochure, "Craftsme In War Production" contains in teresting data on our two plant and details of our 43 years of pr duction experience with meta

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3. Doors—Cabin and Bomb Bay
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8. Nacelles
9. Transport Cabin Benches (Seats)
10. Elevators
11. Vertical Fins
12. Stabilizers
13. Gas Tanks
14. Flaps

Above is only a partial list of parts on which we can offer production help.

LYON METAL PRODUCTS, INCORPORATED

Subcontracting As a Permanent Policy

An integral part of United Aircraft's prewar program, it has aided materially in rapid expansion to meet war schedules.

SUBCONTRACTING by United Aircraft Corporation has proved so successful that the amount of work "farmed out" today ranges up to more than 50 percent of the total volume of work being done by its three operating divisions: Pratt & Whitney Aircraft, Hamilton Standard Propellers and Vought-Sikorsky Aircraft.

But meeting production schedules which have been increased many times since 1939 with the help of subcontractors has not been accomplished without headaches for both the corporation or its suppliers. Rather, building up to the volume now being handled by outside producers has been accomplished over a long period of time in which a valuable backlog of know-how has been accumulated.

United's vast subcontracting program is kept rolling by means of a rather informal committee of executives representing management and production, engineering and purchasing departments, with the latter handling most of the details and liaison work.

Many members of this group are also members of the corporation's War Plans Division which was set up long before the United States appeared headed inexorably toward war and which prepared both the organization and its subcontractors for fast and sizable expansion. To accomplish this the division prepared a series of "M Day Plans," which covered several different expansion programs. Then representatives went to each of the subcontractors and, in effect, said, "What will you have to do, what will you require in the way of

(*Turn to page* 336)

Large-scale production of the Vought-Sikorsky F4U Corsair, shipboard fighter, one of the deadliest aircraft in the world, has been materially aided by extensive subcontracting with parts and subassemblies reaching the final production line from widely scattered parts of the country.

Are you interested in: (1) Reducing time and cost of handling tools and materials; (2) Saving floor space; (3) Increasing protection against fire, sabotage and personal injury hazards?

This comprehensive catalog contains many suggestions for meeting these war-time problems. It illustrates and describes many types and sizes of shop boxes, work benches, portable tool stands and many other items that manufacturers of Airplanes and Airplane Parts are finding most effective in every production operation.

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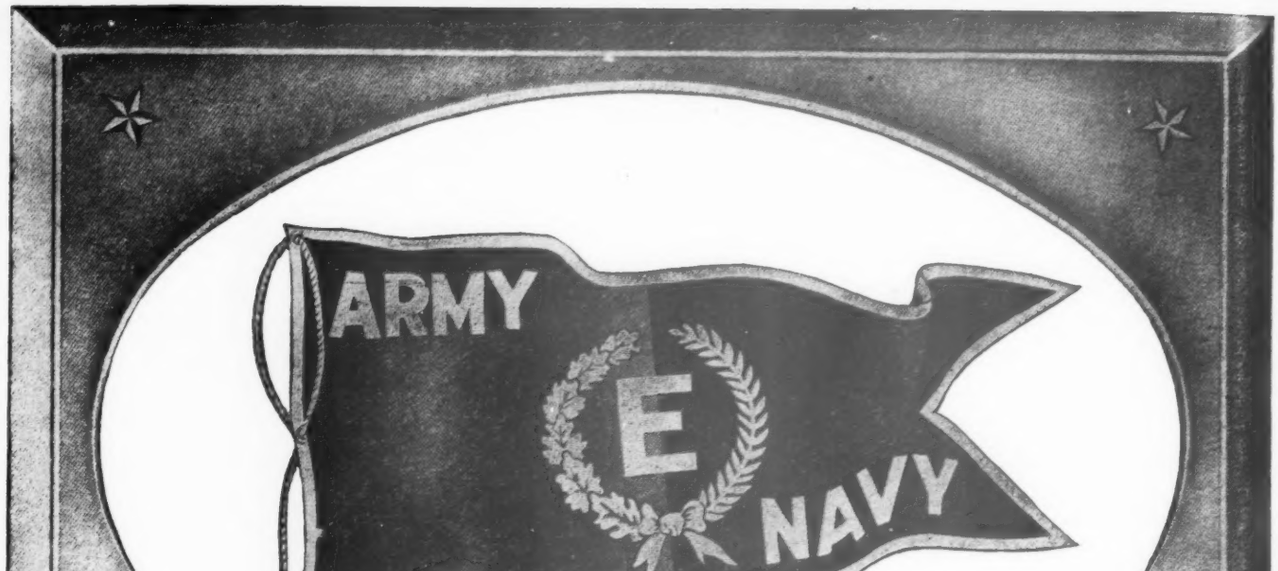

A Salute to Our Employees and to Our Suppliers

As an "AWARD FOR EXCELLENCE" the Army and Navy of the United States of America have given us their highest honor—the Army-Navy "E." With grateful appreciation we acknowledge the debt to our suppliers for their tireless energy and efficient cooperation and to our employees whose faithful work and loyalty have made it possible for us to achieve this signal honor. One of the first 107 companies in the United States to receive this award we are indeed proud to have a part in the great united war production program. Materials of war are being shipped from our plant at the rate of over one hundred carloads per month at present. We hope to do still better tomorrow.

WEBER

SHOWCASE & FIXTURE CO. INC.

LOS ANGELES, CALIFORNIA

Men and Machinery Available for War Work

Continuing its clearing-house of information service to both prime and subcontractors, AVIATION presents more men and machinery available for war production work. Address inquiries to AVIATION, 330 W. 42nd St., New York.

126. An Indiana machine tool manufacturer has superfinishing machine capacities available for subcontracting work. Any general type of cylindrical superfinishing work is desired up to 10 in. dia. by 4 ft. long; centerless work up to 2 to 2½ in. dia. by 4 to 5 in. long. Some types of flat finish work can also be readily handled.

127. A Wisconsin pool, whose member organizations average more than 16 years experience, has some 12,000 manhours per week available, of which 45 percent are listed as highly skilled; 30 percent skilled; and 15 percent semiskilled. Metal working division has 105 lathes; 125 drill presses; 8 shapers; 4 planers; 14 milling machines; 17 punch presses; 8 foot presses; 2 automatic screw machines; 2 internal and 2 external grinders; 2 die cast machines; 2 boring bars; and a list of cutting and welding machines; grinders; polishing and buffing equipment; threaders; shears; presses and bending brakes. The woodworking division has drill presses; band, jig, circular, cutoff, universal and tilting arbor saws; shapers; lathes; routers; upright and belt sanders; single and double spindle boring machines; planers; carvers and a kiln. Chemical division has produced special soaps, disinfectants; surgical solutions; soldering fluxes and leather treating solutions. Equipment includes reaction vessels of from 5 to 600 gal. capacity; stills; filter presses; dilution tanks and vacuum equipment. The organization has a coordinator to assist in allocating work and follow-up on jobs.

128. Oklahoma oil and gas testing instrument manufacturer, now doing aircraft subcontract work, has additional facilities to put to work. Equipment includes 10, 11 and 12-in. engine lathes, 0.001 in. tolerance; a No. 2 Simmons turret lathe, 0.001 in. tolerance; 10 and 14-in. drill presses; horizontal milling machine; 1¼-in. pipe threading machine; band and jig saws.

129. Ohio publishing and printing organization, now working for aircraft producers, offers template making facilities for aircraft manufacturers and subcontractors. Work is done in template department, segregated from plant proper. Templates made of 16 or 18 gage auto body, stretch-o-level steel, duplicating photodraft or master tem-

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Delivered 'On Schedule'

Aircraft parts, manufactured for assembly into this nation's aerial war craft, must be "made right" . . . and delivered "on schedule." There can be no compromise with either element.

Before Pearl Harbor, Aircraft Mechanics, Inc., was fashioning vital aircraft forgings and welded assemblies . . . as subcontractors for most of the major airplane manufacturers.

Since December 7th of last year, we have tripled in numbers of workers, and have extended our operations into floor space four times as large as that previously used—yet, we have maintained the quality of our workmanship and deliver "on schedule" . . . sometimes even in advance of customers' expectations!

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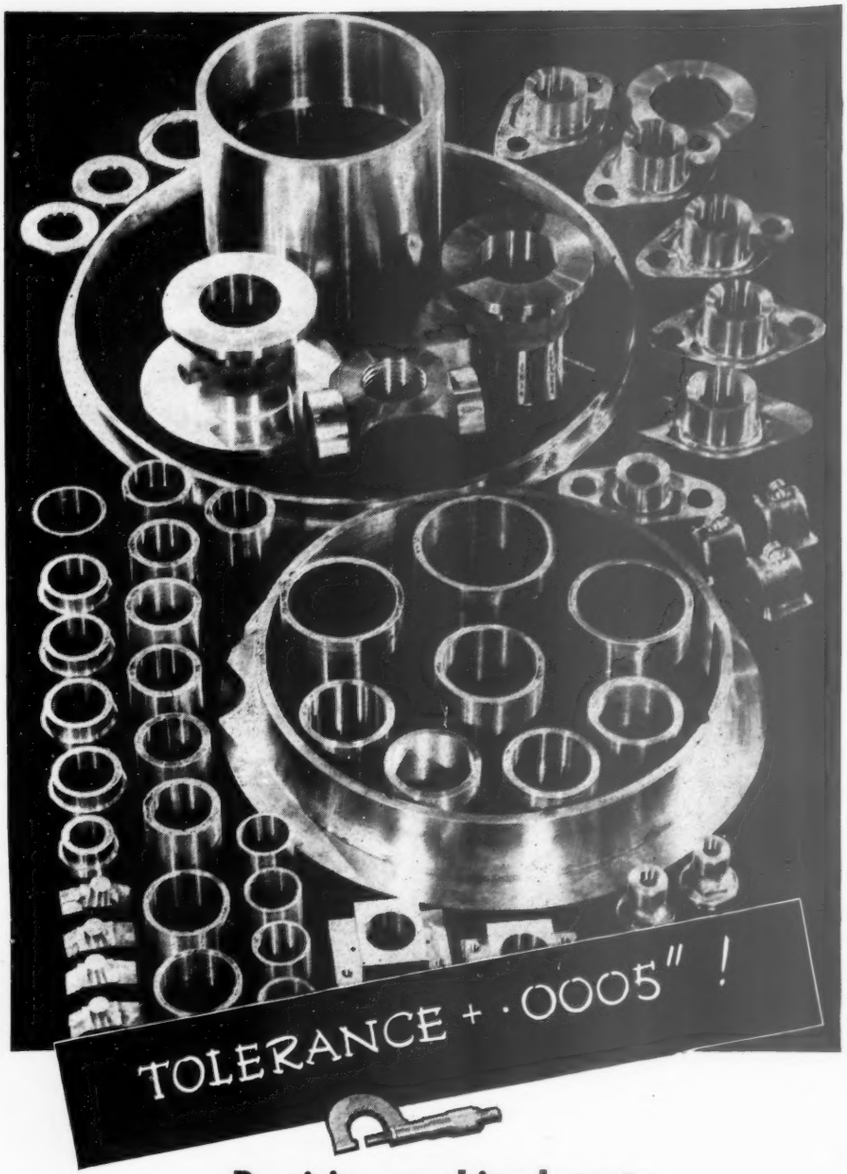
INC.
Colorado Springs Colorado

plates supplied by customer. Maximum size 30 by 40 in.; tolerances 0.005 plus or minus. Has special equipment to handle photodrafts up to 6 by 12 ft.

130. Forty-year old New Jersey producer of filters, pumps and special equipment for chemical, metallurgical and allied process industries with 200 workers, mostly skilled mechanics, now doing some aircraft subcontracting, seeks more work. Foundry can produce about 25 tons of cast iron, 3 tons of bronze, and a ton each of lead and aluminum casting per 8-hr. shift. Machine shop equipment includes ten engine lathes with from 11 to 25-in. swing, tolerances 0.001 to 0.003; two 20-in. turret lathes, tolerance, 0.001; three milling machines, two of 0.001 and one of 0.005 tolerance; five boring machines, 0.002 tolerance; eight drilling machines, seven of 0.001 tolerance; shapers; grinders; cutters; heat-treating and finishing equipment; and welding machines.

131. New York state specialty concern now doing aircraft work has the following equipment: 26 power stamping and blanking punch presses; 300, 600 and 800-ton coin presses; 200, 300, 500, and 800-ton drop hammers; 4 Gorton mechanical pantograph engraving machines; 154 light, medium and heavy foot presses; 13 hand screw presses; 13 eyeletting machines; and 4 hydraulic presses.



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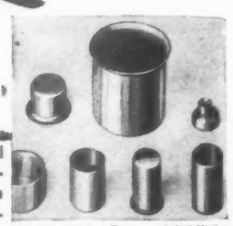

Typical small parts produced on Goat drawing presses for materials from .005" to about 1/16" thick, maximum draw approximately 4" and blank diameter 8". For items running 50,000 to 500,000 total requirements. All types of material. GOAT specializes in the production of stamped, drawn and formed metal parts ranging from .002" to 1/16" metal thickness using all type metals and alloys. Inquires invited.

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The great ships of the air, succeeding ocean liners down the launching ways, will ply the boundless ocean of space — crossing land and sea to carry cargoes directly to port of destination on the fastest ton-mile basis. Such huge transports rely on power by Wright.

WRIGHT *Aircraft Engines*

POWER THE TONNAGE OF THE AIR

Service in Action

Over the far Pacific, through the icy blasts of Alaska, and above the Sahara sands—on a score of widely separated fronts, American planes, fabricated with Boots Self-Locking Nuts, are meeting the severest test of all—war.

And Boots nuts play their humble though important part in getting our planes out to their objectives and back. For they are not ordinary nuts. Born in an era of mass plane production, these ingenious, all-metal, self-locking devices are a time-saving boon on the assembly line. They are lighter, safer, vibration-proof and literally "outlast the plane." Send for new catalogue. Correspondence should be addressed to general offices, not to factory.

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A few of the planes fabricated with Boots Self-Locking Nuts

Boots Self-Locking Nuts For Application In All Industries

BOOTS

BOOTS AIRCRAFT NUT CORPORATION
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HOW IT WORKS

The Boots Self-Locking Nut is one-piece, all-metal—withstands severest vibration. The top (locking) section is displaced in a downward direction so that its locking threads are out of lead with the load carrying threads of the lower section.

Upon the insertion of a bolt, the top section of the nut is extended to engage with the threads of the bolt. A constant force is thus established which locks the nut firmly into position without damaging bolt or nut. Axial thread play is eliminated.

Side Slips

ONCE UPON A TIME, early in the era known as World War II, there sprang up a small group of men who did appoint themselves as Strategists, and Experts, and delivered themselves of much criticism against the warbirds hatched in that State then known as America.

These critics were not themselves of any repute as breeders of warbirds, nor had they attained high rank as guides for the birds. But they were clever in the use of words and writ books, and spoke to the multitudes both from the platform for lectures and through the air by electric contrivances.

Many were the results of these writ and spoken words. Some of the people hailed the critics as Messiahs, and relaxed in their efforts. "These men," they said, "have the magic key for victory," and sweated less. But by sweating less then, they shed more tears later, for more blood was let. Even in those days there was no easy way to win a war. Other people were filled with confusion; surely, they said, "our warbird leaders whom we have chosen cannot be so jugheaded as the critics declare," but the loudness and frequency of the critics' declarations instilled doubts in some. Only a few there were who challenged the critics, and they were much berated.

• AND ACROSS THE SEAS a megalomaniac house painter and a bespectacled little yellowman, both bent upon ruling all the world, chortled in glee. Even though their own birdmen then knew better, it served their foul purposes well to have their enemies confused, divided and lacking trust in their chosen leaders.

And well they might have chortled, for the critics' words were disconcerting. The Curtiss-bred *Hawks,* they said, have not the striking power needed for a warbird. Its Allison-type heart has not the strength to carry it to great heights for fighting. The same, they cried, is the shame of the Bell-bred *Airacobra,* and the Lockheed-bred *Lightning.* We cannot win a war with these birds, they declaimed.

And the sea birds of war—how the critics beat their breasts and screamed of these craft. The sea bird simply cannot be a match for a land bird, they shouted, for it must be bred with weighty attachments for returning to its cote, which is naught but a floating target. What fools you have been, they told the multitudes, for letting your chosen men-at-government waste your gold on these follies.

• EVEN the giant egg-laying warbirds fell afoul of the critics' tongues and pens. These birds, with Pratt & Whitney and Wright hearts, could reach many miles up into the skies—even the critics admitted this fact. But, they said, by going so high, they cannot possibly lay their eggs in the proper places and they will soon become extinct because they lack striking power to defend themselves against the warbirds of the house painter and the little yellowman.

But throughout the world forces were working against the self-appointed Strategists and Experts.

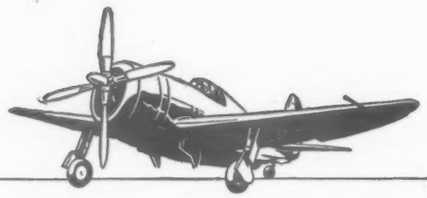
• IN FAR-OFF CHINA men who were known as the Flying Tigers had not the benefit of the critics' vast knowledge. They went into battle with Curtiss *Tomahawks*—those of the small striking power and weak hearts. And they knocked from the skies 218 of the little yellowman's birds while but 84 of their own fell lifeless And in the fog-shrouded Aleutian isles young Americans, heedless of the critics' admonitions, rode into battle on *Hawks, Airacobras* and *Lightnings.* For every one of these birds with the so-called weak hearts which fell dead from the skies, 22 of the little yellowman's were put to death. So it went around the world; despite the preachments of the critics, young men rode to battle and nowhere came out with a ratio of less than two to one.

The sea birds, too, worked against the critics. It was many, many moons before the multitude learned what havoc was wrought against their little yellow-

(*Turn to page* 320)

"Maguire's been like that ever since he got that job as instructor for the WAFS!"

V OLUME FOR VICTORY



HERE IS A GLIMPSE . . .

No single photograph could show you *all* of the Republic P-47 Thunderbolts that are on the line at Farmingdale and at other points . . . Their thunder in the uppermost regions of strato-combat will contribute mightily to the crescendo of victory.

REPUBLIC AVIATION

REPUBLIC AVIATION CORPORATION — REPUBLIC AVIATION — FARMINGDALE, L. I., NEW YORK

Guardians Of the Convoys

A convoy laden with vital war materials plods toward its destination under the protective eye of a Navy K-type blimp armed with bombs, depth charges and guns against Axis submarines. Blimps can operate close to the surface of the water, making them effective even on days of low ceiling and limited visibility, a factor which, it is claimed, makes them superior to heavier-than-air craft for convoying.

Lighter-than-air branch of naval coastal patrol service taking a larger part in keeping sea lanes open for movement of men and materials to battlefronts.

By ESTER H. FORBES

LONG CONSIDERED BY the public as useful only for sight-seeing and advertising purposes, blimps are rapidly coming into their own as military weapons. Day after day they are patroling both Atlantic and Pacific coasts to assure delivery of valuable cargos, justifying the faith placed in them by a small group of naval airmen.

One of the great battles forced on the United States in this war is the battle of transportation—transportation to our Allies, to our own fighting forces abroad, and between ports along our coast lines. An efficient convoy system between North America and England had been established before Pearl Harbor. Since then one of the most pressing problems has been speedy transportation of men and materiel to our distant outposts. This the airlines are accomplishing under direction of the Army's Air Transport Command. When, in the middle of January, Axis submarines began their piracy on our coastwise shipping, we were faced with a third problem of transportation.

We were unprepared for the sub attacks because we had been concentrating on the important job of keeping open our lines to England. Every available escort ship and Army and Navy plane was at that time needed more elsewhere. And so, month after month, merchant ships were sunk off the Atlantic coast, in the Gulf of Mexico, in the Caribbean, off South America, and off the Pacific coast with no apparent end in view.

The Army and Navy, however, were taking steps to protect American shipping and silently putting them into effect. They were gathering in old American and British destroyers and subchasers. They were converting pleasure yachts into fighting ships; receiving a few British trawlers with their crews; getting old and new minesweepers, ocean-going tugs, net tenders and Coast Guard cutters. They were organizing patrol squadrons of Army, Navy and Civil Air Patrol units. Finally, the Navy began to get delivery of 48 K-type blimps which it had ordered from Goodyear some months before.

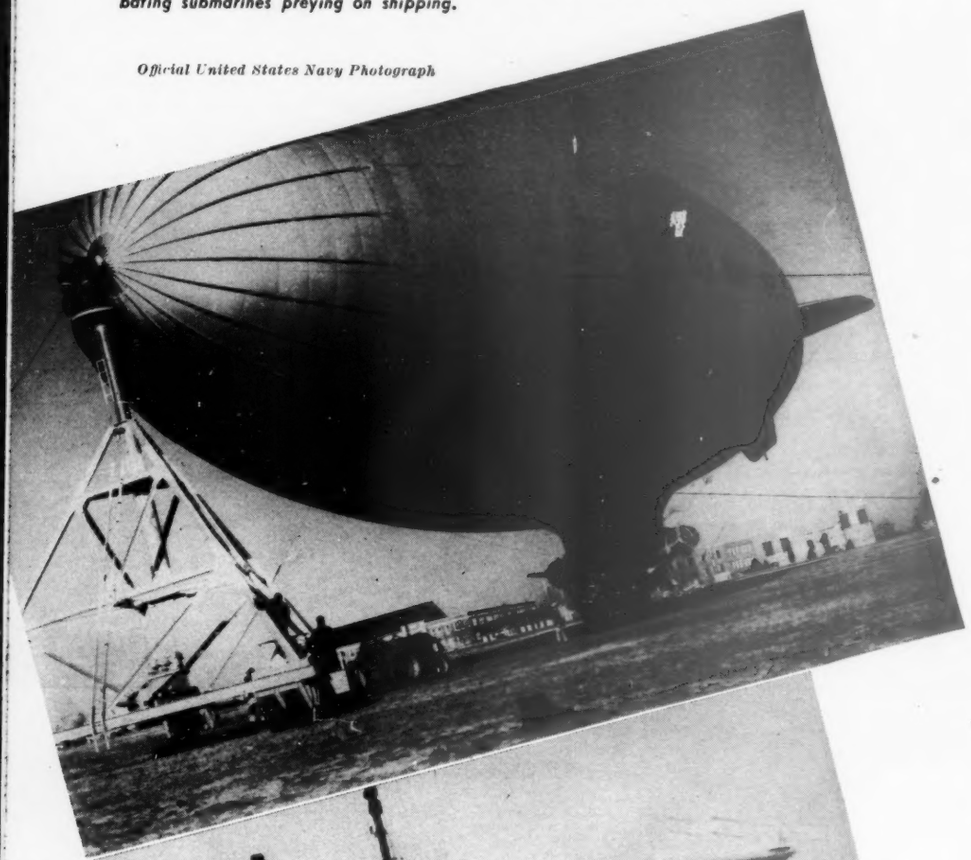
To integrate these surface and air units patroling the Atlantic coast, a new branch of the Navy was created—the Eastern Sea Frontier, commanded by Adm. Adolphus Andrews. Each unit is responsible to the commander of its base,

who, in turn, is responsible to the commandant of his Naval District or to an Army Bomber Command. Navy and Army operations are then coordinated by the Commander of the Eastern Sea Frontier. Likewise, the Pacific coast patrol is directed by the Navy's Western Sea Frontier.

Coordination on such a vast scale takes time. Though by the end of March there were some patrol planes and ships on duty, it was not until May 14 that the first coastal convoy got under way. From then until July 14, hundreds of ships were moved in convoys up and down the Atlantic, and of these only two were sunk by enemy torpedoes or shells. Since then the total number of sinkings has decreased so consistently that American marine insurance underwriters have reduced their rates twice within a month, giving credit for these reductions to "new and improved methods of convoying and other protective measures."

A K-type Navy blimp on its mobile mooring mast prepares to shove off for convoy duty. These lighter-than-air craft have proved particularly effective in combating submarines preying on shipping.

Official United States Navy Photograph



Gun crews on convoy patrol have been given added "eyes" by Navy blimps cruising far and wide over vital supply routes.

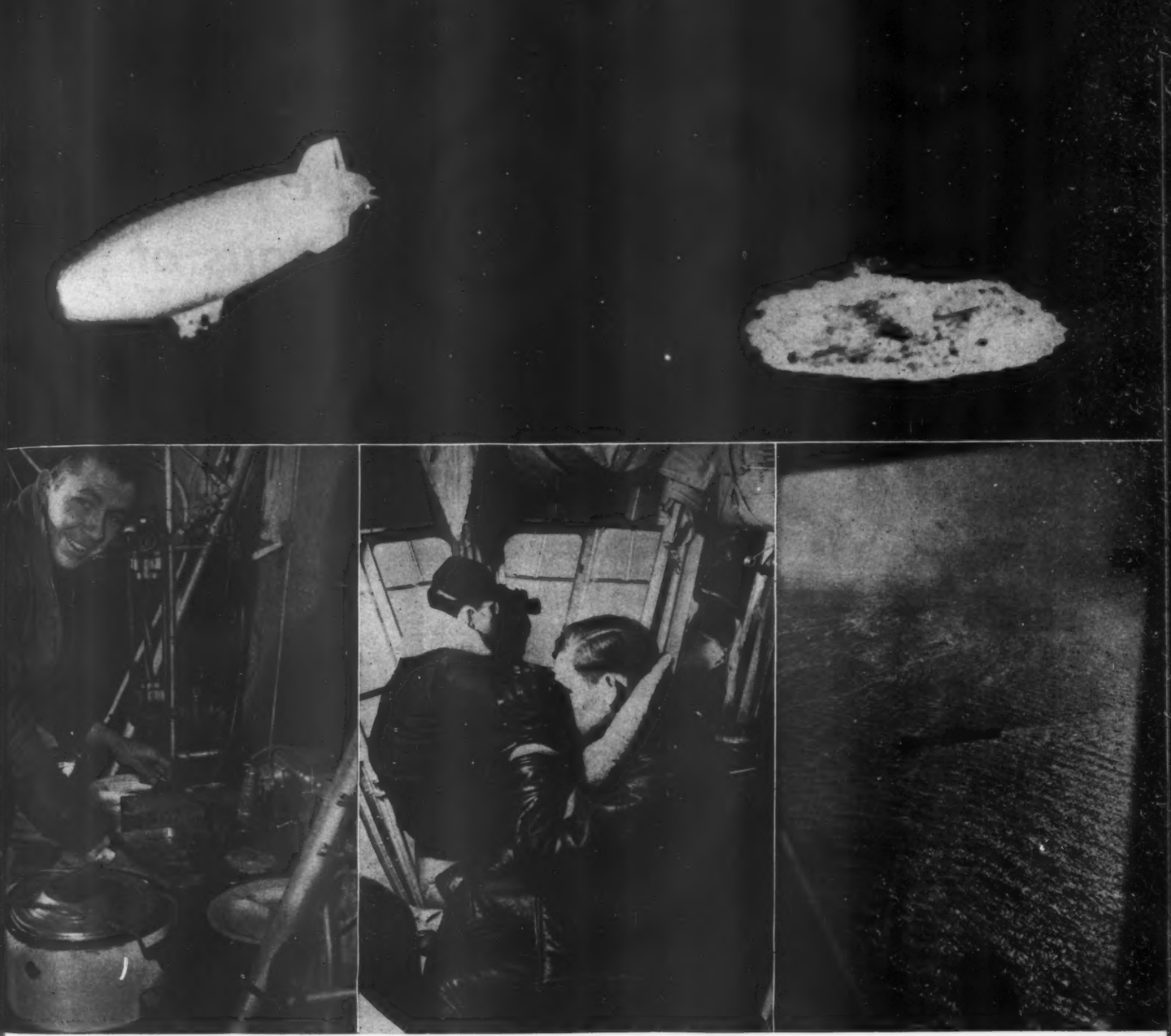
Outstanding among these "new and improved methods" are the Navy's K-type blimps. Their use, of course, is practicable only with complete air supremacy. But this we have over our Atlantic and Pacific coasts, and blimps are diminishing the activities of Axis subs, and far surpassing the expectations of their most enthusiastic advocates. As one naval officer put it, "They can do everything that a plane can do —plus."

Their plus value comes from the fact that they are at the same time both lighter than air and power driven. They can navigate slowly enough to keep pace with the ships in a convoy and, if need be, hover for hours over one spot. They can operate from a few feet off the water and thus stay under the clouds in low visibility. Moreover, a blimp can carry enough gasoline for a good 1,500-2,000-mi. trip.

Blimps, comprising the Zeppelin Patrol Group, are now operating over the Atlantic, and on the Pacific coast a similar group is flying.

Unlike planes, the K-ships usually fly alone. From a squadron one blimp may be assigned to a northbound convoy, a second to a southbound convoy, and others to specific areas where submarines may be lurking. At any time one of these blimps is likely to get a message from its base that a ship or plane has spotted on enemy submarine. The blimp is given the submarine's longitude and latitude, its probable direction, and told to get it. Easily maneuverable, the blimp quickly turns and speeds to the designated location. With its long cruising range the blimp can stay on the search for hours. Then, once it has closed in, its secret detecting devices together with its ability to hover while the ordnance men take aim spell almost certain doom for the undersea craft.

Just how many submarines the K-ships have destroyed is still a military secret. But it is no secret that the Navy is so pleased with the performance of the blimps that it has ordered hundreds more. To meet these orders the Goodyear Aircraft Corporation has already expanded its Midwest plant and is now building a blimp assembly plant twice as large "somewhere



Wide World

TOP: The terrific impact of the depth charge is illustrated by the size of the water crater in comparison with the Navy blimp from which it had been dropped. The exact number of submarines destroyed by Navy patrol blimps is a military secret, but it is large enough that Congress has authorized a vast expansion of this branch of the service.

LOWER LEFT: The blimp's long cruising radius means long stretches away from the base—but Uncle Sam's lighter-than-air sailors eat, and eat well, just the same.

CENTER. All crew members of the blimps act as lookouts, constantly on the alert for telltale traces of submarines while "riding herd" on convoys. The blimp's ability to hover over one spot for long periods of time, together with secret locating devices, help them keep on the trail of undersea craft until bombs or depth charges can do their work.

Wide World

LOWER RIGHT: Navy Coastal Patrol blimps check on all "stray" vessels, reporting their movements to headquarters as part of the coordinated Army-Navy-Civil Air Patrol work in keeping the sea lanes open for movement of men and materials to American and Allied fighting forces all over the world.

in the Southwest." Nor it is a secret that the Navy is organizing additional blimp squadrons in the South and West.

There can be no doubt in the mind of anyone who has been to one of the lighter-than-air bases recently that the Navy is counting heavily on blimps to protect shipping until the war is over. All day long, while the K-ships are out on convoy and patrol duty, scores of smaller L-ships are dotting the skies on training flights. The L-ships usually stay close to home so that the aviation cadets can concentrate on takeoffs and landings, the two most difficult and exacting maneuvers in blimp operation. After 250 hr. of actual flight training, however, the cadets become experts.

In addition to the pilots, these bases also train the other members of a K-ship's crew: Navigators, riggers (gunners), ordnance men (bombardiers), machinists, radio men and their couriers. The couriers are homing pigeons, and every patrol flight carries six crates of the birds. If communication becomes impossible, these pigeons can leave the ship during flight and return to their base with vital messages. Their training, like that of the other crew members, is highly specialized and is being greatly expanded.

As more and more K-ships and crews report for action, the blimp patrol will assume a larger and larger share of coastal patrol duties, relieving sorely needed bomber and patrol planes for offensive action. Having helped to win the battle of transportation along both our coasts, it will take a larger part in safeguarding this victory.

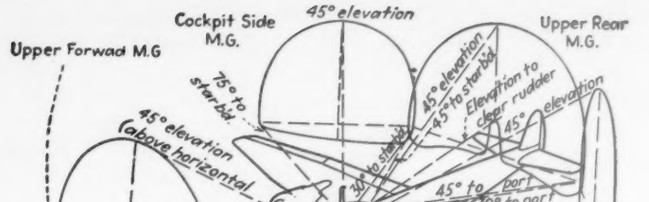


Fig. 1

Fig. 2

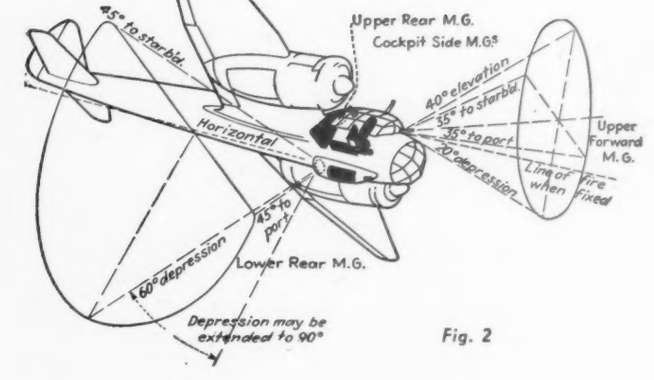


Fig. 3

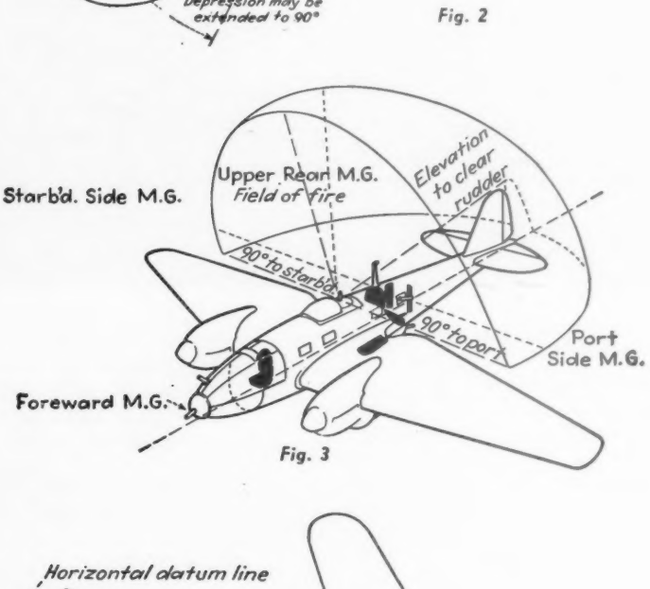

Horizontal datum line
Side M.G.
40° to starb'd.
45° to port
Lower Rear M.G. Field of fire may be extended to 90°
This gun found occasionally
Lower Forward M.G.
Field of fire

Fig. 4

Fire Power Details of Nazi Planes

Arrangement and areas of protective fire screen show vulnerable points.

AS IS POINTED OUT by Maj. Nathaniel Silsbee elsewhere in this issue, no airplane is better than its armament.

On these pages are shown some of the reasons why quantity alone could not entirely compensate for quality in the Luftwaffe's attempts to wipe out the RAF and Red Air Forces. It should be noted that in the vast majority of cases the Nazi planes depend on 7.9-mm. machine guns—about the same size as .30 calibre—and the only shell guns used are 20 mm. While the British still rely largely on .30 calibre for their machine guns, they have long had a policy of mounting more guns than the Germans. It should also be noted that the Luftwaffe still relies heavily on the planes shown here. American practice has long called for nothing smaller than .50 calibre, half again as large as either the 7.9 mm. or .30 calibre, but with approximately three times the impact force.

Bombers Have Vulnerable Spots

The JU 88 (Figs. 1 and 2) is used for long-range level bombing, dive bombing, photographic and reconnaissance work, carrying a crew of three or four, depending on the mission, and mounting up to six guns. Forward fire power depends on one or two 7.9-mm. machine guns or, occasionally, one-20 mm. shell gun, operated by a navigator-bombardier. This gun can be swung 35 deg. to either side; 45 deg. up and 20 deg. down. Lower rear protection depends on a 7.9 operated by a crew member who lies facing backward. It can be swung 45 deg. to either side and, normally, 60 deg. below horizontal. This depression can, however, be extended to 90 deg. Protection from above and behind depends on one crewman—who is also radio operator—firing two 7.9's with a 45 deg. swing to either side and an elevation of 45 deg. This crewman also operates either of two side 7.9's, swinging from 30 to 75 deg. off center, and 45 deg. above horizontal.

The Heinkel He 111 (Figs. 3, 4 and

5), a long-range bomber, torpedo carrier or reconnaissance plane, is one of the "workhorses" of the Luftwaffe. Protection from the rear depends on one 7.9 which has a quartersphere arc: from horizontal to vertical and 90 deg. to each side. This operator also handles either of two 7.9 side guns, swinging from 15 to 85 deg. off the center line and 35 deg. above and below horizontal. Protection from below is afforded by one or two 7.9's or one 7.9 and one 20-mm. shell gun, operated by a prone crewman facing backward. This installation has a 45 deg. swing to each side and down as much as 90 deg. Occasionally the plane is fitted with a 7.9 firing down and a little forward through an aperture in the compartment which juts out below the fuselage. Forward fire power is furnished by one or two 7.9's in the fuselage nose, operated by the bombardier, who lies beneath the pilot's seat. Forward fire screen is 35 deg. to each side, 15 above horizontal and 35 below. Occasionally another 7.9 is mounted, swinging from vertical to 20 deg. above horizontal and 35 deg. to either side. Recently some Heinkels have been equipped with either a 7.9 or a grenade tube, fitted into the tail and operated by remote control. (See AVIATION, October, 1942, page 157.)

Fighter Fire Concentrated

The Messerschmitt ME 110 (Figs. 6 and 7) twin-engine fighter is well armed forward, but is light in both rear and lower fire power and armor. Forward fire power consists of four 7.9 machine guns and two 20-mm. shell guns, all firing from fixed positions. (Also see page 98.) Sole protection from the rear is from one 7.9, which can be swung but 40 deg. to either side, up 60 deg. above horizontal and to 10 deg. below. With a service ceiling of 32,000 ft., the plane has a top speed of 340 mph. at 22,000 ft., and cruises at 285 mph. at 16,500 ft.

Stuka Lightly Armed

The JU 87b (Fig. 8), the still widely used *Stuka*, has been proved to be extremely vulnerable without over-powering local air superiority. Its forward fire power consists of two 7.9-mm. machine guns in the wings, firing outside the propeller arc. Protection from the rear depends on one 7.9 which can be swung only 30 deg. to either side, 45 deg. above horizontal and a little less below horizontal.

All the guns shown—the 20-mm. shell guns as well as the 7.9's—must be swung by hand, for the Germans have done almost nothing with power turrets.

(For other armament and armor details see AVIATION, August, 1942, page 196.)

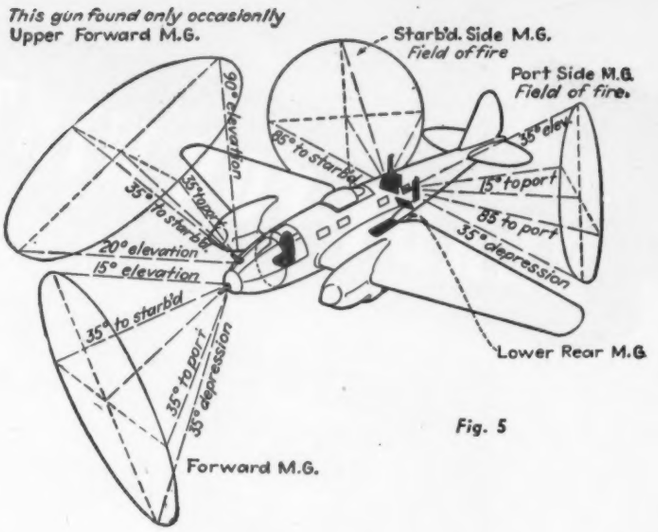


Fig. 5

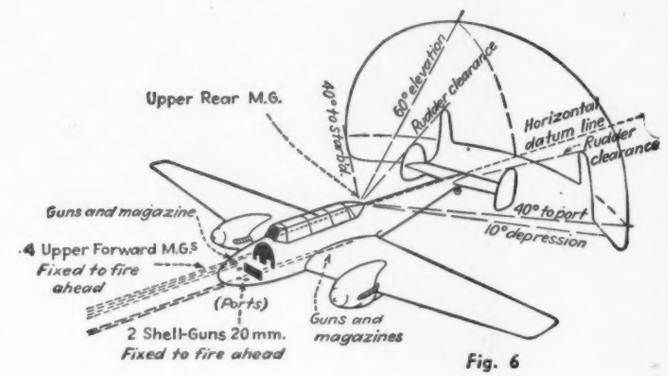


Fig. 6

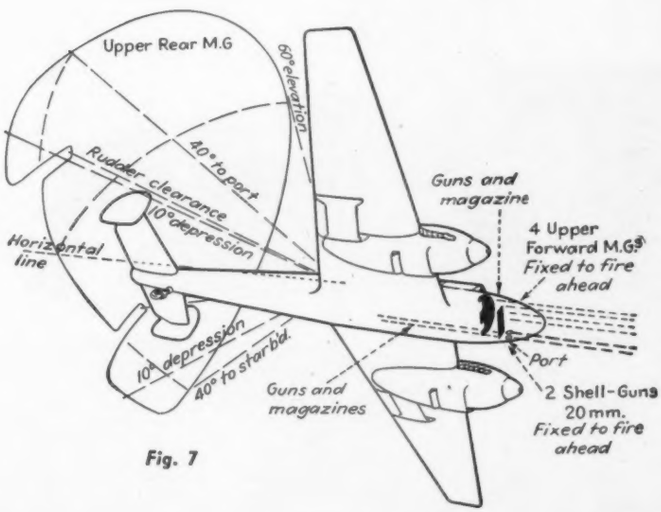


Fig. 7

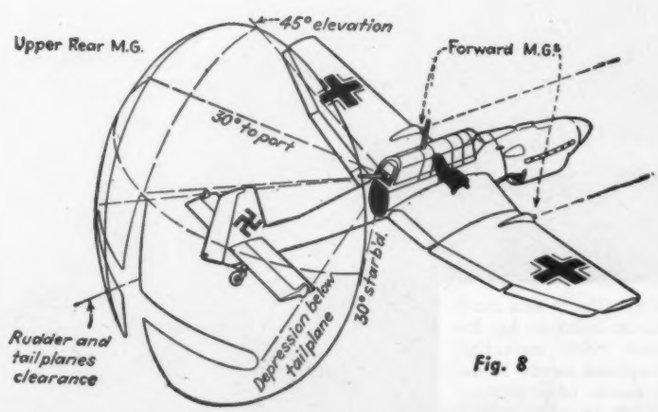
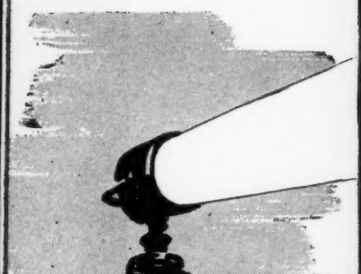


Fig. 8

BE READY FOR WINTER'S ATTACK

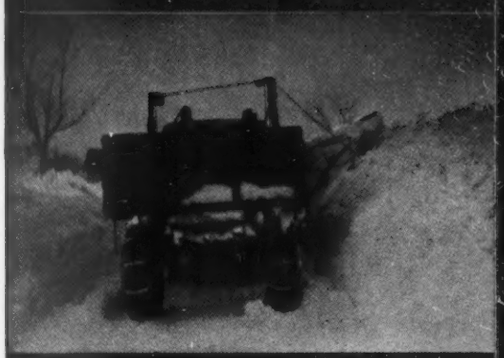
INSPECT AND EQUIP YOUR FWD's NOW . . . FOR FAST LOW-COST AIRPORT SNOW CLEARING



Hundreds of FWD's, similar to this model, will soon be put in harness for the winter's work—fitted with mounting equipment and snowplows ready to get into action fighting snow, after a busy spring and summer on regular airport maintenance work.

FWD

KEEPING 'EM IN THE BLUE . . . . Calls For Good Clear Runways Below . . . .



Keep 'em flying by giving 'em runways clear and clean of snow. At airports in every state in the snow belt and many Canadian provinces (where heavy snowfalls are a constant menace) FWD trucks are being made ready for snow clearing duty — a service in which they have earned and kept first place.

In cooperation with the aims of the U. S. Truck Conservation Program, FWD lists here a few practical suggestions to enable airport operators to get the most in performance with minimum maintenance out of their FWD snow removal trucks:

Conserve tires—snow removal truck operators are universally agreed that single tires are best in snow removal service. The use of single tires of the same size on all four wheels not only conserves rubber but also reduces excessive differential action, thus prolonging the life of the truck. Closely spaced tire chains—not emergency chains—should be used on all four wheels, for maximum traction and least slippage and damage to tires.

Care of engine—change engine oil frequently enough based on total hours of operation. Keep cooling system clean and free of rust. Control engine temperature with a radiator hood or automatic shutter.

Storing the truck — sub-zero temperatures make lubricants too stiff and solid, cause steels to become brittle. House all your trucks when not in use — avoid outdoor storage for longer truck life.

Inspect your trucks—periodically and check for needed replacements — take advantage of FWD's principle of progressive interchangeability of improvements and vital parts.

See Your FWD Branch or Dealer

The entire FWD organization of factory branches, FWD dealers, and district servicemen are all pledged to help you get the most out of your trucks by aiding your program of preventive maintenance. Call on them frequently for sound maintenance advice and skilled service.

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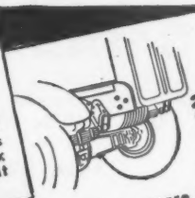
FWD
TRUCKS
—THE PREFERRED TRUCK FOR FAST, LOW-COST AIRPORT SNOW CLEARING

1 No swerving—FWD's front driving and pulling wheels hold the truck to a straight line.



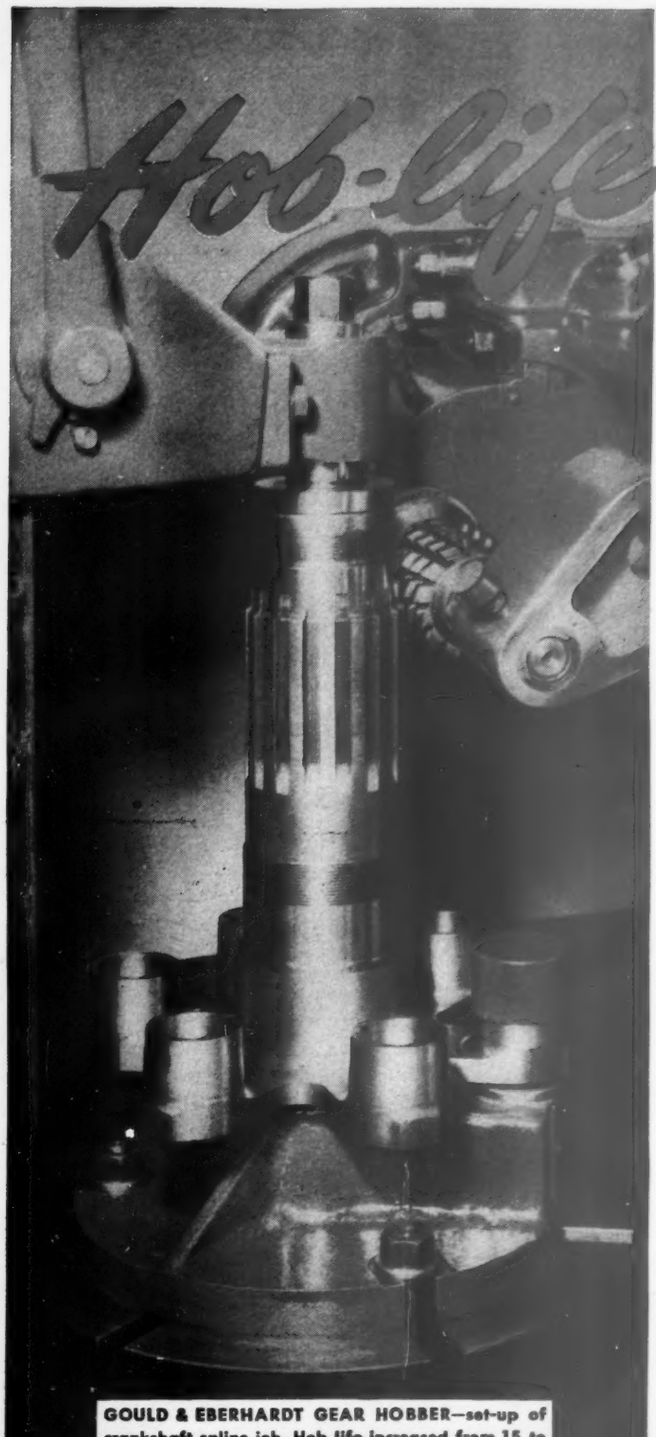
2 Removing the front bumper from the FWD provides a convenient, completely drilled, square frame for rigid snowplow mounting.

3 With snowplow in place, an FWD carries approximately 50% of its weight on each axle — insures proper balance for easy handling.

4 Complete safety for the driver —FWD cabs are sealed against carbon monoxide infiltration.

5 Full traction — all the weight distributed on both axles of the FWD is used in aiding the full powered traction.

FOUR WHEEL DRIVE TRUCK PROVIDES SO MANY OUTSTANDING SNOW REMOVAL ADVANTAGES



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better surface finish
heat dissipation

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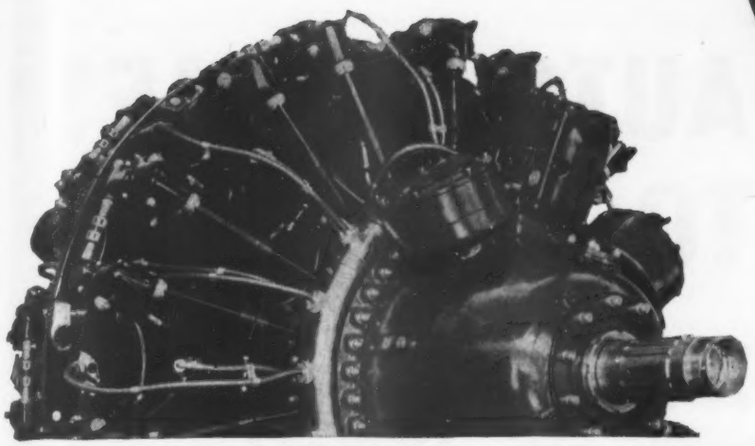
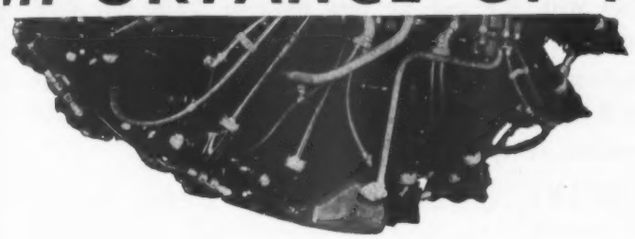


IMPORTANCE OF PISTON RINGS in Aircraft Engine Maintenance



Piston rings are among the most vital of the precision engine parts. Their application for full engine performance is largely a maintenance problem.

By PAUL S. LANE, *Research Engineer, Muskegon Piston Ring Co.*

LESS THAN SEVEN POUNDS of cast iron—84 1¼-oz. pieces for each 1,200-hp. engine. Piston rings—the only engine parts made of cast iron—are so vital to full engine performance that they constitute one of the most important maintenance considerations.

Cast iron is a relatively weak metal (compared with steel) but possesses unusual properties which have so far made it the best metal for piston rings. As used for rings, it is really an alloy of iron (92 percent), silicon (3 percent), and carbon (3.75 percent), with lesser amount of sulphur, phosphorus, and manganese.

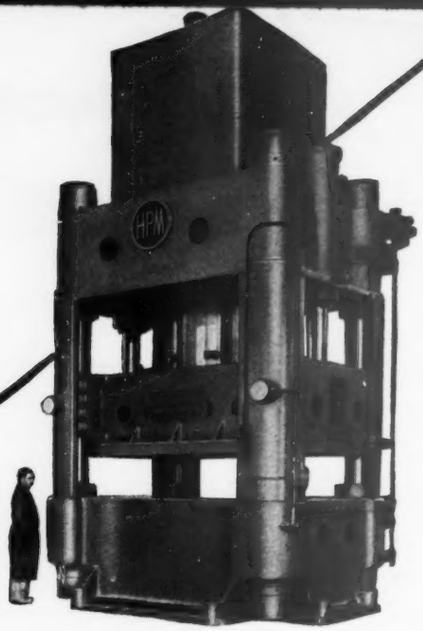
Structurally, the iron contains nearly 10 percent graphite carbon by volume, and this element, present as a mechanical mixture, gives the material its unctuous or soapy qualities. It is a "bearing metal" type of structure made up of hard and soft discrete particles. These characteristics are believed to account largely for the oil retaining, wear, and scuff resisting qualities of the metal. Cast iron is well known for its anti-sieze, gall-resisting action, and for its ability to heal its rubbing surfaces.

Physically, piston-ring iron has excellent heat resisting and elastic properties, and as a cast, a tensile strength of 45,000 to 50,000 psi. The hardness is 225 to 275 Brinell (Rockwell B-97-104-AMS Spec. 7310). These high physical properties are obtained largely as a result of the method of casting.

Sticking rings, resulting from heat and carbon deposits, were once regular offenders. To combat this trouble the engine manufacturer demanded rings of better flatness since an out-of-flat ring is sluggish in the groove and is more prone to sticking. Also, as carbon adherence on the sides of the rings promoted sticking, a smoother side finish was called for. Rings of only a few years ago were "smooth ground" with a surface roughness of around 50 micro-inches. Now many rings are lapped, giving improved flatness, and a surface measuring only 6 micro-inches in roughness. This smoother finish is believed to reduce carbon adherence and piston groove wear. The flatness and finish of the piston grooves also influences ring sticking.

Oil economy is largely determined by the piston rings used. To get best efficiency for a given piston ring set-up, it is necessary that the ring contour and fit against the cylinder be as perfect as possible. Furthermore, the hardened cylinder barrels now in general use in high output engines are particularly sensitive to lubrication control, and to the sharpness of the scraping edges of both oil and compression rings. Hence a first-quality ring must have complete cylinder bearing all around its periphery and the scraping edges burred, but held to print limits for radius or sharpness. A radius of 0.010 in. on the skirt ring will result in marked increase in oil usage. Also, if the finish on the cylinder barrel is too smooth (say, less than 6 micro-inches), the rings will not seat and high oil consumption is experienced. If ring faces are mutilated or scuffed during break-in running (as may sometimes occur due to low oil pressure), the desired oil control is not likely to be obtained.

Scuffing and wear are closely associated with the amount and cleanliness of the oil supplied to the rubbing surfaces. During green runs, when mating of the surfaces takes place, the engine consumes large quantities of oil, but must at the end of this run be "conditioned" so as to meet Air Corps requirements when operated on the "final acceptance" runs. Rings must therefore be correct as to structure and hardness of metal and also have a finish on the



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periphery conducive to quick seating. Blowby during the early running periods will destroy the upper cylinder lubrication and ofttimes will result in scuffing and scoring of rings and cylinders—even though large quantities of oil are burned. In other words, adequate lubrication is not always indicated merely because the engine shows high oil consumption. Many factors, of course, can influence such conditions, but it will be apparent from this limited outline that the piston rings are critical to successful engine operation, even before the engine is ready to fly. A paper by Donald U. Kudlich of the Wright Aeronautical Corporation, entitled Engineering Liaison and Production Control, published in the May, 1942, issue of the *SAE Journal* deals in part with piston ring scuffing and oil control, and is recommended for those particularly interested in this subject.

Replacing Rings at Overhaul

The procedure to be followed when installing new piston rings in aircraft engines at the time of overhaul varies with different engines. It is strongly urged that in all cases reference be made to the overhaul manual published by the engine builder. The data given in these manuals is the result of broad experience with each particular engine, and optimum results will be obtained by following the instructions given therein.

It may, however, be desirable to sketch briefly the re-ring practice used on a 5½-in. Pratt & Whitney *Twin Wasp* engine of 1,200 hp., though attention is called to the fact that the data shown is given in more complete form in the Pratt & Whitney overhaul manual.

Cylinder Reconditioning

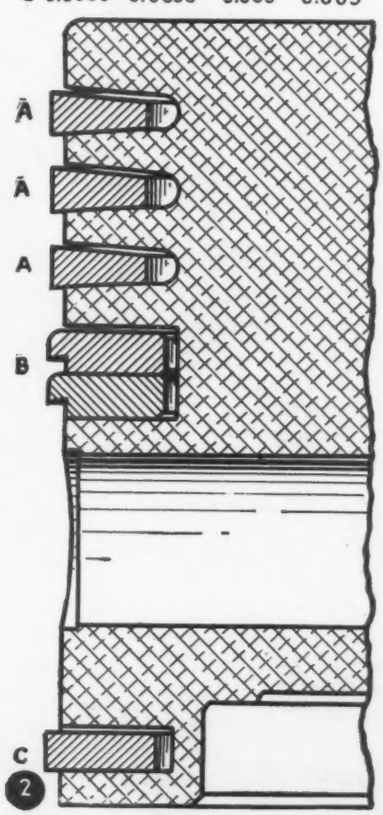
In most cases a cylinder is considered suitable for re-ringing if the wear has not exceeded 0.006 in. on the diameter. As to the amount of taper and out-of-roundness, it is generally recommended that each of these must be held to a maximum limit of 0.006 in. in order to consider the cylinder suitable for re-ringing. If any of the measurements show greater than 0.006 in., regrinding to oversize or new cylinders are recommended. Regrinding of nitralloy barrels is not recommended. The step or ridge resulting from wear in the cylinder, at the top of the piston ring travel, can be removed simply by using a hand stone or by means of a small portable grinder. When this operation is carried out, care must be taken not to grind beyond the upper end of the top ring travel, and it is important that the surface be blended to the adjacent part of the cylinder wall as perfectly as possible. Unless this ridge is properly blended or removed, ring breakage of the new top ring is apt to occur.

The barrels on this particular engine have a "choke" of 0.015/0.018 in., starting at the shrink band of the cylinder head and extending approximately 2½ in. up the cylinder barrel. This choke feature provides a straight cylinder at normal engine operating temperatures. If the cylinders are reground straight,

(*Turn to page* 339)

1

	END GAP	SIDE CLEARANCE
A	0.0595 – 0.0665	0.003 – 0.005
B	0.0565 – 0.0635	0.004 – 0.007
C	0.0565 – 0.0635	0.003 – 0.005



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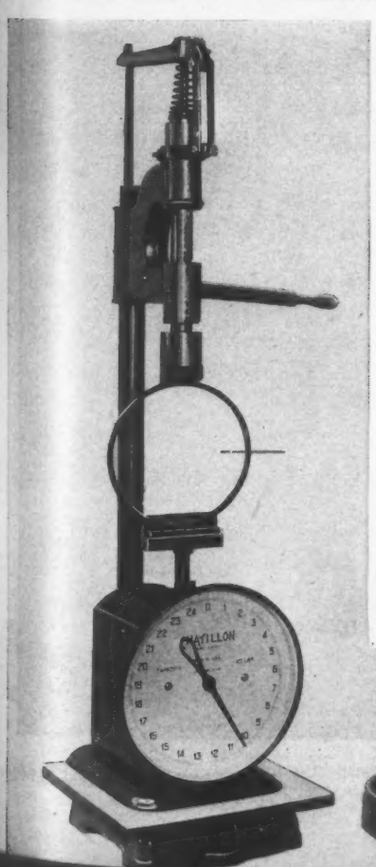

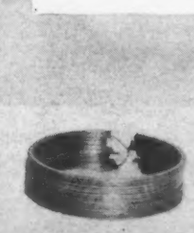

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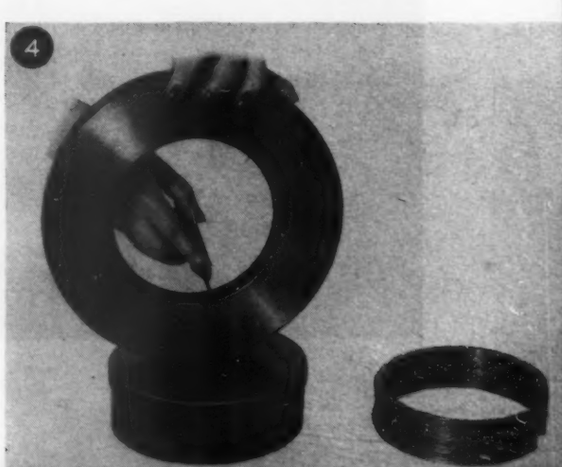

4

FIG. 1. Typical piston and piston ring set-up used in high output aircraft engines. This piston contains the ring designs shown in cross-sectional form in Fig. 2 . . . FIG. 2. Cross section view of 5½-in. aircraft engine piston ring showing recommended side and gap clearances. The fourth groove containing the dual oil rings and the bottom groove with the plain compression skirt are drilled to return excess oil to the crankcase . . . FIG. 3. Piston ring tension test. The ring is closed diametrically to the specified gap clearance, and the load required is indicated by the spring scale . . . FIG. 4. Checking gap for end clearance. This gage is made to cylinder diameter and the clearance between the ends determined by means of feelers. If the rings are fitted with insufficient end clearance, breakage is likely to occur.

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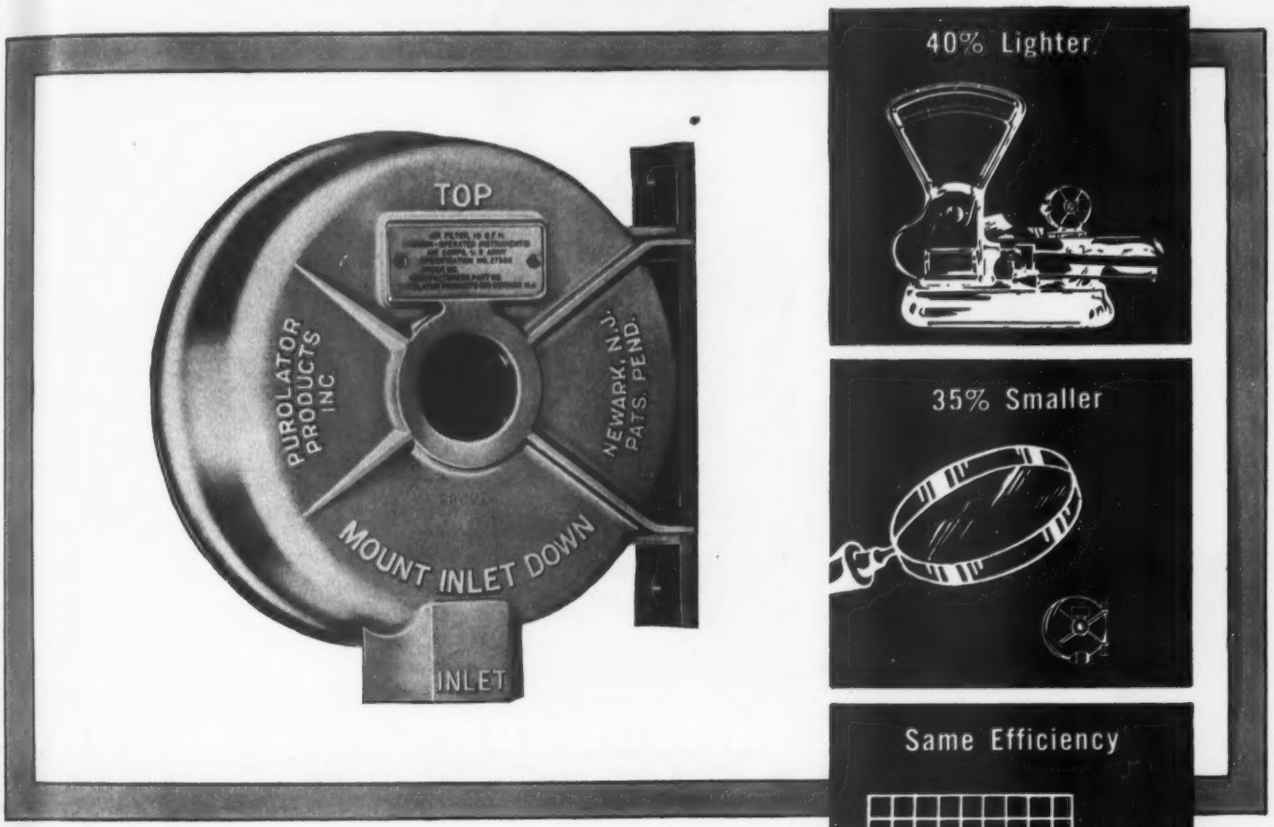

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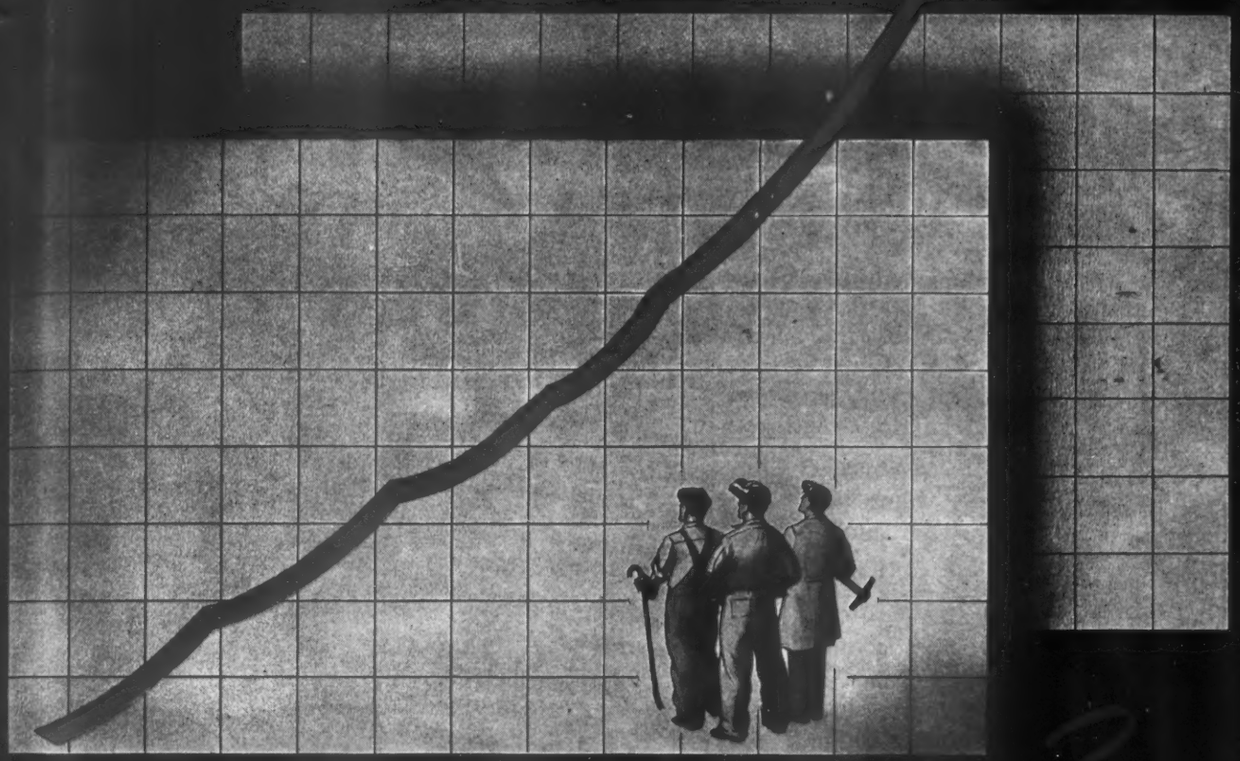

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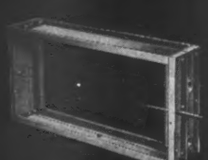
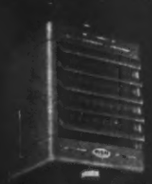
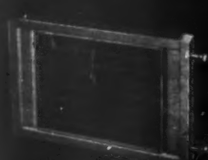


MARINE VENTILATING



CANTONMENT HEATING UNIT



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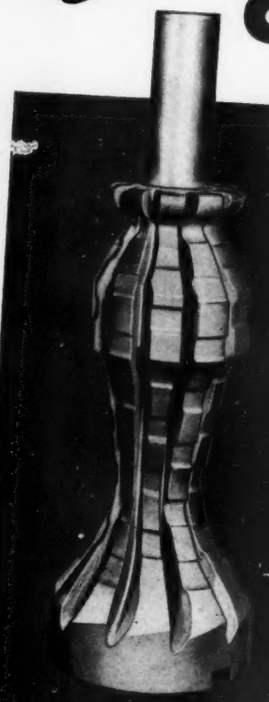

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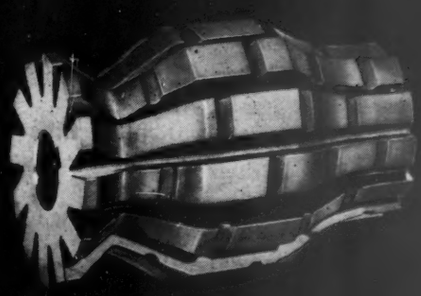

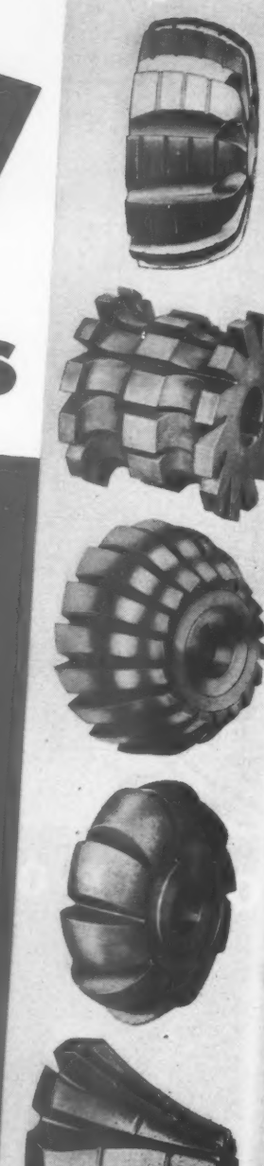

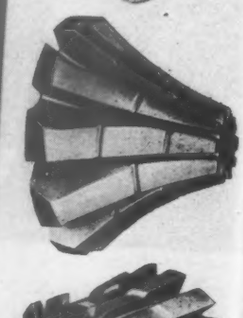

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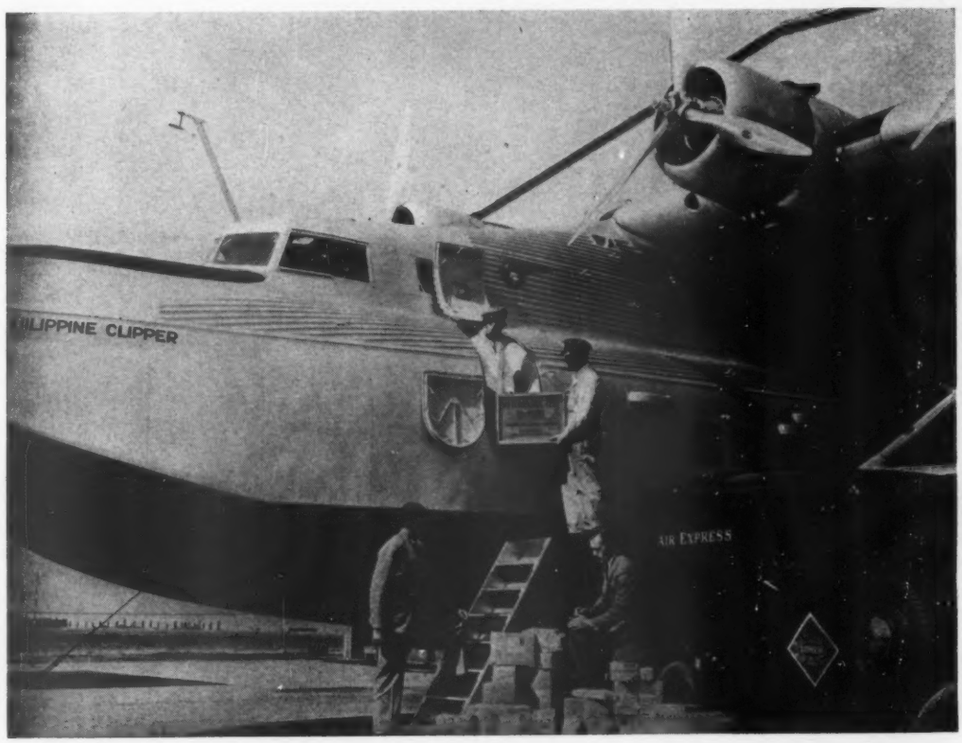


Pan American Airways photo

The impetus given development and expansion of air transport by the exigencies of war assures for it a new role in international commerce after the war.

By GEORGE F. BAUER

International Trade Commission

WILL WORLD TRADE depend principally upon airplane transport after the war? Are most of our products going to be sent to other lands by cargo planes and shall we receive by the same kind of transportation many of the material riches that other regions throughout the globe have to offer us?

A review of the fundamentals which underlie international commerce, particularly those which may be affected by air transportation, will give us guidance toward the answers.

First of all, what is international trade? Is it very much different from domestic business? If it were not for languages and man-made boundaries of nations, we would find these differences to be similar to those arising in trade of the citizens of certain of our States with the people of other States. In both foreign and domestic trade, people of one section offer their products and hope to obtain the goods of people in another section; in domestic trade the sections are in the same country; in world commerce they are in different nations.

The more that goods can be exchanged by one group for the largest possible supply of products of another, the more there is to go around of all kinds of goods for the well-being of all.

This presupposes that in effecting the exchanges of goods, the tributes of an intermediary nature for handling, financing, transportation, supervision and distribution are kept within reasonable bounds.

If airplane transport of persons or goods tends to decrease these intermediary costs in international trade, to what

degree will it be welcomed as a most helpful agency in advancing the standards of living in terms of abundance of goods for people everywhere?

Under the capitalistic system, increases in volume of sales abroad are dependent on the same conditions normally found here. A large demand for any product can best be developed through a decrease in the cost to the public. After the war, the conception will no doubt again acquire merit that you greatly increase the number of sales as you bring down the cost of the product to final consumers.

In international trade there is a great difference between what a producer receives for his goods and what the final user pays. Intermediary charges enter heavily into the calculations. It is not infrequent that goods selling at retail in a producing point in the United States for $100, have to be sold at twice that amount at some foreign point.

The intermediary costs so forceful in boosting the prices to foreign buyers result from charges for export boxing, inland railway service, lighterage and loading at seaboard, ocean freight, marine insurance, consular fees, duties, port and transport charges, financing, conditioning and distribution.

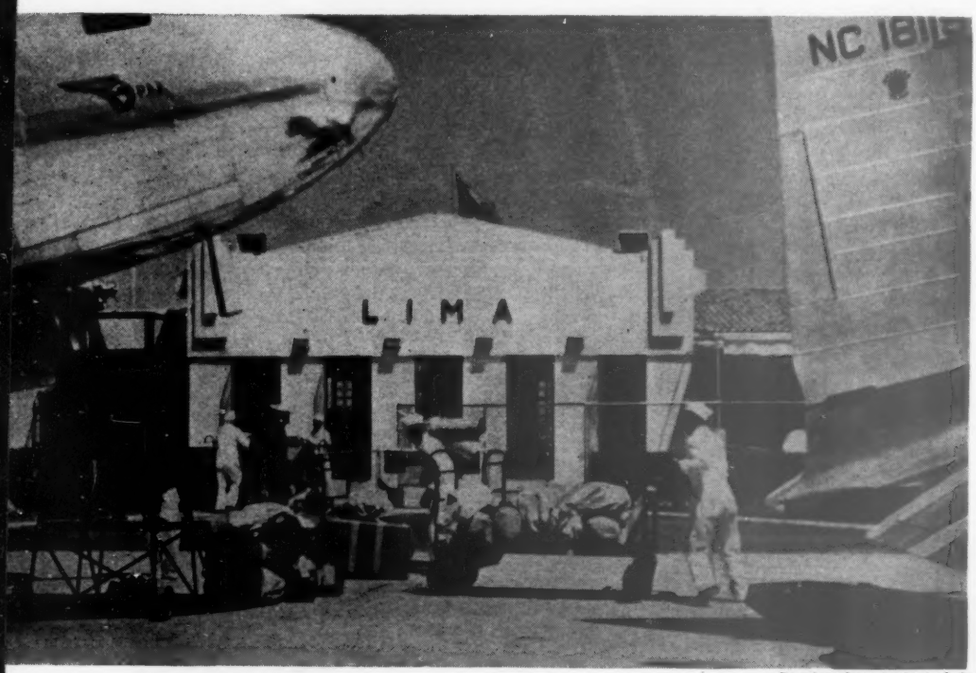
It is in this area between the prices paid to the producer and the prices exacted from the foreign buyer that air transport already has acquired great importance and will assume even more.

In export salesmanship, the airplane already has definitely provided vast economies for the American business firm desiring to extend its contacts abroad. Formerly an executive wishing to visit distributors in Argentina had to tarry 18 days on a steamer. Now he can fly there by plane in about four days. For the manufacturer sending him, there is a saving in the salary of an executive for a period of two weeks. Expenses for actual accommodations by air or steamer are very little apart. Through the airplane, the development of overseas markets has consequently become a decidedly less costly undertaking than in the olden days.

This saving in sales promotion expenses as result of smaller total travel costs, including salary outlay, transportation, hotels and foods, can be passed on to final buyers abroad. This one development tends to bring goods of all kinds within buying reach of increasing numbers of people everywhere.

Actual transportation of goods by airplanes was already well developed before the war started. Shipments of service parts to distributors in various parts of the world were not unusual, but after the war, with the great advances in air cargo ships, they will multiply rapidly.

In an address before the Foreign Commerce Club of New York a little while ago, Grover Loening stated that the "air method of shipping is no less than 25 times as fast as what is now used. Aircraft can travel over the oceans of the world at 250 mi. an hour—compared to the desperately slow pace of 10 mi. an hour that your average freight ships have to go at."



Pan American Airways photo

Transshipments of air-borne goods will become less frequent as products will go forward from centers of production to places of buyers with less intermediate loading, unloading and warehousing.

Air Transport

What does this advantage of speed by the air cargo plane mean in terms of intermediary costs of goods in world trade?

The saving in interest charges will loom as a most important one from an international viewpoint. Goods on the oceans of the world, if shipped by cargo airplanes, would require only 1/25 of the time now needed to arrive at their destination. Money represented by these products would consequently only be tied up for 1/25 of the present time now involved in the shipping period.

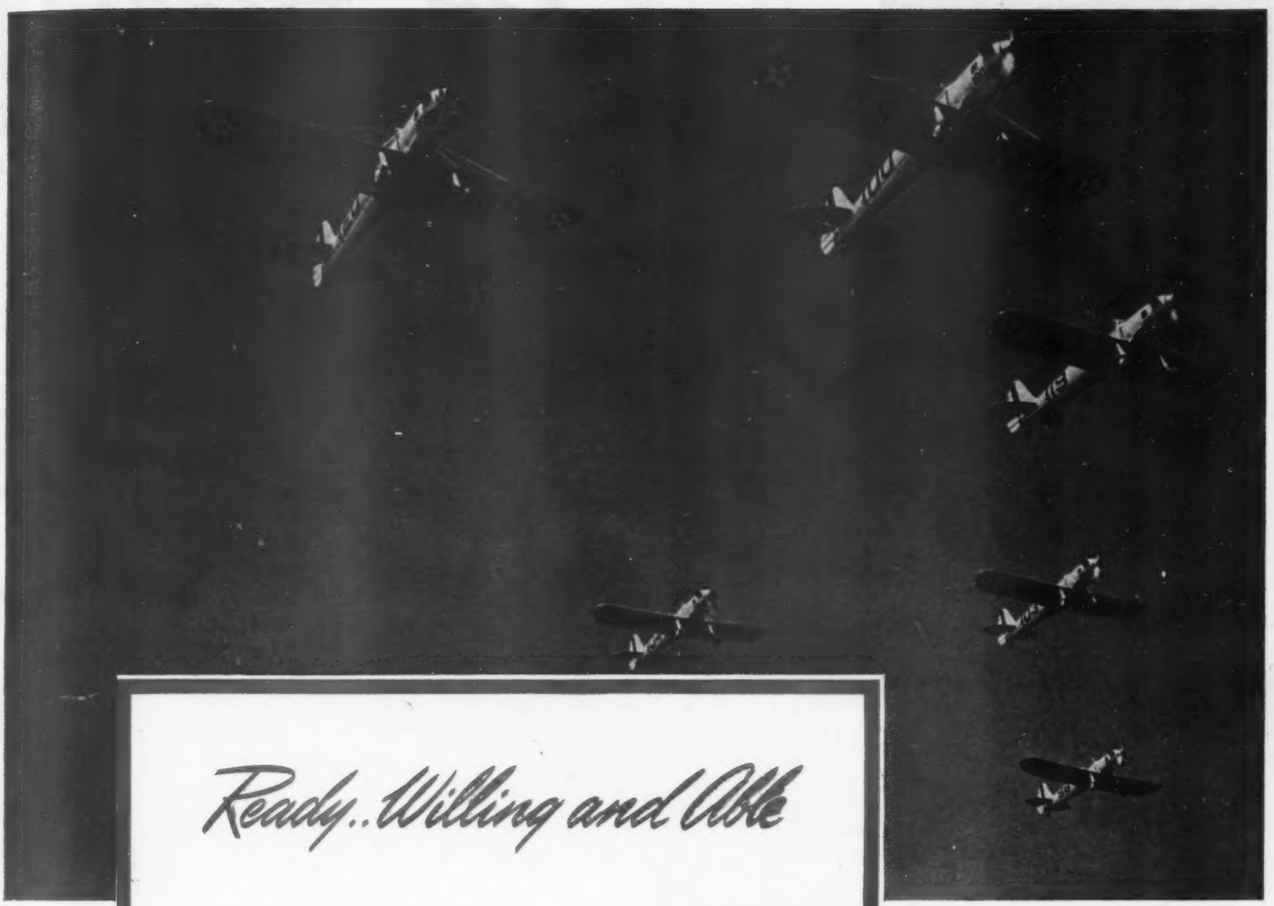
Normally the export and import trade of the United States may be estimated at $800,000,000 a month. The interest charge, if conservatively calculated, would amount to ½ percent, but for every quantity on the high seas there is at least a like quantity in inventory carrying another ½ percent interest charge.

The monthly foreign trade of the United States is consequently subjected as result of sea traffic delays to an interest charge of 1 per cent on $800,000,000, or $8,000,000 monthly, or $96,000,000 a year. With cargo airplanes the time tied up in shipments and inventories could be cut to 1/25 of the time now required. The interest charge would be cut to $3,800,000. This one item would make an annual saving on our foreign trade of more than $90,000,000 and accordingly permit acquisition of additional real goods by that amount by our foreign customers and us.

Actually, the time saving factor will also apply during periods that goods are shipped from the interior to seaboard and from the foreign seaport to the interior of the foreign country. This time economy may be estimated at half of the period involved in the ocean voyage by freighter as against cargo plane, or in terms of added interest savings, $45,000,000 a year.

The time factor, then, favors the cargo plane as against the freighter when related to interest charges on goods tied up in voyage or in inventories.

What about the direct cost factor? According to Mr. Loening, "commodity shipments can be shipped on a modern freight vessel at less than ½c. a ton-mile. It appears equally evident that with use



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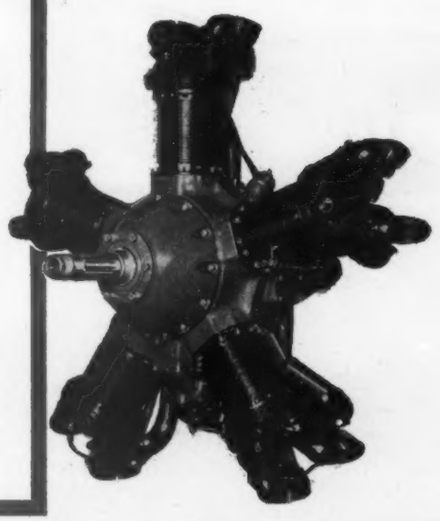
THOUSANDS of Kinner Engines are on the line, ready night and day to serve the Army, Navy and the C. P. T. P., in their ceaseless job of primary training.

And this performance is matched by the production ability of the men and women who build Kinner Engines. From the factory to the flying fields Kinner...and Kinner Engines are ready, willing and able!



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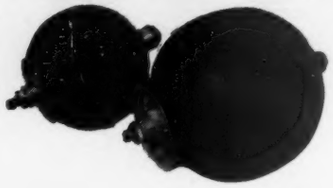

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Latest achievement of Bendix Aviation, Ltd., engineers is this continuous shell hydraulic accumulator, already specified on several of America's new, spectacular airplanes soon to be announced. It is lighter... meets new AN specifications and, like other Bendix Aviation, Ltd., equipment, its simplicity assures fast volume manufacture. The 5" and 7½" size are now going into production for volume deliveries during 1943, and Bendix has the capacity to meet *your* requirements.

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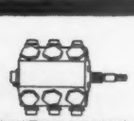
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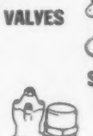
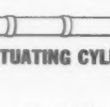

PRESSURE REGULATORS

CHECK VALVES


RELIEF VALVES

HAND PUMPS

RESTRICTOR VALVES

of gliders and new developments in prospect, transoceanic air costs will run about 5c. a ton-mile."

Offhand it looks as if the direct cost factor now favors the freighter as against the cargo plane.

During recent years very fundamental changes occurred in the methods of conducting foreign trade. Finished goods have been sent abroad in decreasing quantities whereas the tendency to send parts and components for assembling in plants abroad has increased. Certain economies in freight space requirements, boxing and shipping charges have been the reasons; this transition favors the cargo plane.

With freighters there has been difficulty in adapting the cargo to the ship. In most instances it was absolutely required to prepare the cargo to fit in with the limitations of a freighter.

There was insistence, for example, on proper boxing of goods, a requirement quite understandable from the viewpoint of the ship's operator and yet most costly from that of the final buyer abroad. The claim was made that facilities in foreign ports were inadequate and that the cargo would be spoiled unless fully protected by boxing. Nevertheless, there were instances when a mere shipping box resulted in an increase of 13 percent in the cost of the goods it contained. It was not the cost of the container as such, but rather the pyramided charges assessed on it with freight on a weight basis, customs duties and internal taxes on the increased cost, that brought about this situation.

Boxing is one thing that should be capable of great modification, when not entirely eliminated, in shipments by cargo planes. Wrapping, too, may not require the same expenditure as when goods are under way a long time on the seas.

Insurance, one of the intermediary cost factors, may also be favorably affected by air transport. Need for transshipments under trying conditions in many unprotected harbors will diminish and thereby reduce breakage—an important component in determining insurance rates.

Transshipments, themselves, may become less frequently necessary as goods will go forward from centers of production to places of buyers without costs of excessive hauling from factory into railway freight cars, onto lighters, or into lighters, trucks and steamships with consequent unloading at destinations, and then again, onto piers and into

Pan American Airways photo

Crating and container needs for air cargoes in most cases will be simpler and lighter than those required for ocean shipping. Many savings will be reflected in reduced weight and costs.

foreign freight trains and final delivery by truck to the overseas merchant. These operations can be most costly and must indirectly enter into the prices paid by overseas customers; their elimination or reduction will be a factor favoring air cargo planes.

Congestion at seaports tends to make for higher rentals for warehouses in which to store goods pending customs examinations prior to distribution to major parts of a country. With landing fields scattered over a wide area and goods brought closer within reach of the merchants who ordered them, the chances of congestion diminish and local facilities with their more reasonable rentals can be brought into use. In some cases, the buildings of local merchants can become bonded warehouses thereby creating additional savings that always follow when congestion is avoided as happens when ports no longer become bottlenecks of traffic.

Local transport means, possibly belonging to merchants, themselves can be utilized and the expenditure for hiring of such vehicles at ports with high operation costs avoided.

All of these intermediary charges when prorated on individual products become considerable and, if their avoidance is gradually made possible by cargo planes, the transition to them from present methods of transportation will be impressive.

In the trade among individuals, the speed factor definitely favors air cargo ships; the intermediary cost factor needs

(*Turn to page* 280)

Pan American Airways photo

Movement of manufactured goods abroad by air will reduce intermediary costs, such as financing and insurance, and will cut inventories and warehousing requirements.

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Financing the Airlines

By SELIG ALTSCHUL

PRESENT-DAY DISCUSSIONS of the future of air transportation inevitably come around to the tremendous capital requirements faced by the industry in its postwar expansion.

For example, Eastern Air Lines has asserted that its contemplated expansion program would require additional capital of about $200,000,000. American Airlines vaguely speaks in terms of $650,000,000. By contrast, the assets of the entire air transport industry, at last count, aggregated less than $70,000,000.

These potential requirements have tempered the enthusiasm of many impartial observers toward the glowing future commonly associated with the airlines. The ways and means of subsequent financing are also receiving the active attention of airline officials. Further, the Civil Aeronautics Board has designated this general topic as a major phase of the broad survey to be undertaken by its new research division. This entire financing approach is deserving of a careful, penetrating analysis so that a program may be evolved to fit the best needs of the industry. More than a mere financial pattern for the industry is involved: major economic, political and social forces will all be influenced by the fiscal policies adopted.

Yet, the answer to the financing dilemma is as simple as it is direct. Basic recognition must be accorded the airlines' fundamental economic position.

It has been said that technological progress is the basis of modern civilization. However, along with the gains and constructive results achieved, this progress has left destruction and loss in its path. An improved machine or procedure usually destroys the standing and utility of the preceding tool or process.

All this is particularly pertinent to aviation. The effects and counter-effects of technological progress find no richer illustration than in the field of transportation.

Transportation Progress Traced

The Conestoga wagon, horse-drawn over rough roads, was the predominant transportation medium in the United States and the basis of a thriving industry up to the early part of the last century. Then came the canals. Much of the canal capital was lost with the technological development of the railroads around 1840.

Ultimately, the railroad facilities of the United States reached an investment aggregating more than $32,000,000,000. Technological progress continued with the advent of the automobile at the turn of the twentieth century. The private automobile and truck transportation are estimated to have already cost railroad security holders between $15,000,000,000 and $20,000,000,000.

The forced-draft development of aviation during the war is bound to see a tremendous application in peace-time with substantial inroads on railroad passenger and freight traffic. This will be accompanied by still further losses in railroad values. It is also likely that the airplane may cause some deep-seated adjustments and losses in the automobile industry. Shipping companies already concede their potential decline to air transportation.

The march of technological progress in transportation clearly shows that no one medium has any assurance of remaining the dominating influence in the field. The day of the airplane is definitely here. But in some tomorrow, aviation may be seriously challenged by a newer mode of travel or by an improved form of an established transportation medium.

The lessons of the past and the challenge of the future dictate that the airlines be financially sound at all times. *This condition can best be attained if definite provisions are made for repayment of borrowed capital obtained to finance any expansion program undertaken.* This proviso, for example, would have saved the railroads many a later day ailment.

Exactly three years ago, this writer, in AVIATION, showed the facility in financing new equipment acquisitions by trust notes and bank loans and outlined the all-important principle of providing for the amortization and payment of debt over the useful life span of the equipment so acquired. The contention was further advanced that a more balanced capital structure can gradually be attained with equity issues representing the working capital and fixed assets, and equipment notes or comparable paper for the most part, supporting the "flying" assets.

A few case histories illustrate the facility with which air transport fleets were financed.

When American Airlines embarked upon its ambitious equipment buying program late in 1935, the banks refused to finance the purchase of transport planes on the ground that aviation was too risky and that the resale market for planes was limited. Whereupon, American applied to and obtained from the Reconstruction Finance Corp. total loans of $1,236,000 at 5 percent to finance its initial purchase of 20 Douglas DC-3's costing $2,060,000. The company's equity in this equipment at the outset was 40 percent. The RFC took a chattel mortgage on the equipment and provi-

TABLE I—OUTSTANDING CAPITALIZATIONS—AIR TRANSPORT INDUSTRY

(As of June 30, 1942)

	Common Stock Shares Out.	Pref. Stock Shares Out.	Equipment and Bank Loans.*
American Air Lines	574,848	50,000	.....
Braniff Airways	400,000	.....	$416,667
Colonial Airways	260,000	.....	54,000
Chicago & Southern	167,730	32,773	225,000
Continental Air Lines	250,906	7,500	.....
Delta Air	195,156	.....	.....
Eastern Air Lines	572,178	.....	.....
Mid-Continent Airlines	389,399	.....	150,000
National Airlines	270,000	.....	.....
Northeast Airlines	300,000	.....	.....
Northwest Airlines	234,920	.....	142,500
Pennsylvania-Central	331,790	75,000	.....
Trans. & Western Air	950,173	.....	1,250,000
United Air Lines	1,500,451	.....	.....
Western Air	409,954	.....	203,000

NOTE: * Since June 30, 1942, all of the equipment and bank loans indicated have either been retired in entirety or substantially reduced from the proceeds received from the sale of equipment.

TABLE II—STOCK FLOTATIONS OF DOMESTIC AIRLINES

(Since Aug. 22, 1938)

Company	Date	Security	No. of Shares	Offering Price	*Price Oct. 1, 1942
American Airlines	Jan. 1940	Common	50,000	$36.50	$41.50
American Airlines	Oct. 1940	Preferred	50,000	105.00	101.00
Braniff Airways	April, 1940	Common	100,000	10.00	5.75
Chicago & Southern	July, 1940	Common	65,000	7.50	5.25
Continental Air	April, 1941	Common	50,000	3.80	2.125
Continental Air	April, 1942	Preferred	7,500	10.00	†
Delta Air Corp	June, 1941	Common	60,000	9.50	9.50
Eastern Air Lines	May, 1940	Common	110,909	32.00	27.375
Mid-Continent Airlines	Dec. 1938	Preferred	40,000	2.50	Retired
Mid-Continent Airlines	Mar., 1940	Common	50,000	4.00	2.50
Mid-Continent Airlines	Oct. 1940	Common	100,000	5.00	2.50
National Airlines	April, 1941	Common	40,000	7.50	5.00
Penn-Central	Nov. 1940	Common	60,000	15.88	9.75
Penn-Central	Nov. 1941	Preferred	75,000	25.00	23.00
Trans. & Western Air	April, 1940	Common	119,154	14.00	12.875

Source: Securities and Exchange Commission Reports.
Note: *Bid prices used where no listed markets available.
† No market. Privately held.

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sion was made to amortize this indebtedness over a four-year period.

After the RFC demonstrated how profitable equipment loans could be, the banks became very solicitous in extending credit for transport purchases by the airlines.

One example is the simplicity attached to the loan granted Transcontinental & Western Air early in 1939. The airline borrowed a total of $300,000 from a New York bank at 3 percent, to apply against equipment purchases. This loan, unsecured, was to mature serially in 2½ years. Subsequently, TWA arranged with a group of banks for a four-year unsecured revolving credit to provide funds for equipment purchases and for other corporate purposes. The maximum amount of this credit, $2,500,000, was to decrease to $1,000,000 by the fourth year, and the interest rate was fixed at 2¾ percent.

Equipment Trust Financing Ideal

The equipment trust is in the forefront as a device for the air carriers to acquire extensive plane fleets in the future. The first true aviation equipment trust financing, similar to the "Philadelphia Plan" used in the railroad industry, occurred in January, 1939, when Pan American Airways, in order to finance its new Boeing *Clippers*, arranged for the sale of $2,500,000 in 4 percent equipment certificates to two New York banks. Pan American paid 30 percent of the purchase price of the planes in cash, the remaining 70 percent becoming available through the certificates. Provision was made for the certificates to mature serially from Jan. 1, 1940, to Jan. 1, 1944. In this manner, the company arranged to purchase its new equipment on a "pay-as-you-go" basis and to acquire title to the planes at the end of five years.

Basically, the inherent strength of equipment trust obligations is present in the indispensable character of rolling or "flying" stock to the carrier operation. The right of way, roadbeds, terminals and other properties, although essential to the operation of a railroad, have very little value without rolling stock. Similarly, an airline may have a certificate for a valuable route, but it is non-productive without the necessary flying equipment. In normal railroad operations, there is considerable interchange of equipment regardless of geographical location. Due to the essential nature of this equipment, its standardization and ready interchangeability, an obligation based upon its ownership reflects less the fortunes of the individual carrier than does any other railroad obligation. This same condition can, with equal force, apply to the air carriers. The airlines are every day giving new evidence of the practical interchangeability of equipment. This condition should greatly facilitate the use of equipment trust paper in airline financing.

TABLE III—BARRON'S STOCK AVERAGES

	Aircraft	Air Transport	50 Stocks
October 2, 1942.....	31.92	*23.03	62
September 25, 1942...	31.30	21.12	61
September 18, 1942...	29.72	20.28	60
September 11, 1942...	29.28	20.44	60
October 3, 1941.....	37.35	22.41	72

* New high for 1942.

Present Capital Structures Simple

The future capital requirements of the air transport industry promise to exceed by a substantial margin any funds previously obtained by the group. Moreover, extremely large capital outlays may be required over a relatively short period of time.

Fortunately, the airlines have grown and developed with relatively simple capital structures—common stock carrying the burden. There is but a negligible amount of indebtedness in the industry. The capitalization for each of the domestic airlines is presented in Table I and illustrates the simplicity attached to the industry's present financial structure. The airlines not only have a sound base from which to develop their future requirements but the very nature of the industry's operations is conducive to a favorable financial policy.

For example, railroads and other public utilities such as electric power and gas companies require extensive fixed plant and equipment commitments. This includes right-of-way, tracks, bridges, stations and similar facilities in the case of railroads; and power lines, transmission and generating plants for the electric utilities. The airlines, while having certain property of a long-term permanent nature, have not yet been faced with comparable "fixed" investments.

It is also likely that the capital markets will favor financing which provides for definite retirement of debt. Even before the war, many commercial banks discovered the good credit risks and profitable sources of business the airlines provided. As the large institutions have seen a substantial evaporation of business loans formerly granted old-line clients, it is logical to assume that the more enterprising banks may seek to develop extensive credit accommodations for the air carriers. The same premise is true for insurance companies and other fiduciary institutions. Large investment trusts may also become a factor in supplying funds for the industry.

Not to be overlooked is the guarantee of the government likely to be invoked in order to bolster these credits. This would be consistent with the present policy of endorsing loans extended by private capital to the aircraft industry and many war projects.

The anticipated plentitude of funds, competitive factors and the possible government guarantee should all make for low-cost financing to the airlines.

Avoiding Investment Ills

Such circumstance would also avoid too much reliance upon the investment banker. On the whole, the influence of investment banking on the air transport industry has been far from salutary. The airlines have had to pay a high cost for whatever assistance that has been extended by the investment bankers. For example, in February, 1936, Chicago & Southern paid 20.3 percent of the gross proceeds to market its preferred stock. Even as recently as July, 1940, the airline paid 21.3 percent of the gross to sell additional common stock. More importantly, the influence of investment bankers on the industry's management prerogatives, wherever exercised, has been far from wholesome.

Equipment trust financing can also avoid much unwholesomeness that frequently attaches itself to private stock deals. For example, even at this date there is much askance as to the "special" conditions which surrounded the private placement by American Airlines of 50,000 shares of common stock on Jan. 31, 1940. On that date, the stock sold in the market as high as 47¼. Yet the issue was placed at $36.50 per share. The reasons advanced by American's C. R. Smith being that when the financing was first discussed on Nov. 27, 1939, the price of the stock on the exchange was $37 per share, and this private placement was made on an economical basis. Seasoned investment observers were of the opinion that regardless of the previous fluctuations, existing market conditions were such that the company could probably have obtained a net price materially in excess of $36.50 per share through a public offering.

CAB Policies Important

Additional equity financing in any event will be experienced by the industry. The needs of working capital will dictate as much.

Surprisingly enough, however, Chairman Pogue of the CAB, in his separate opinion in the American Airlines mail rate case, advocates the "preservation of simple common stock capital structures as far as possible." In other words, if Mr. Pogue had his way, common stock would continue to carry all of the load in the industry. This is a well-intentioned but highly academic approach and is definitely counter to the financial facts of life. Can Eastern Air Lines, for example, sell a new stock issue of $200,-

(*Turn to page* 279)

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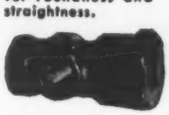
Mild Steel Clevis. Honing was used to correct errors of previous machining and maintain true alignment of the two bearing surfaces of this clevis.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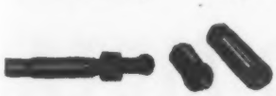

Airplane Engine Parts accurately honed to a super-smooth finish.

Aviation Hydraulic Cylinder made of Aluminum-Alloy. Improves the quality of the bearing surface. An extremely smooth surface-finish is secured.

Hardennd Steel Gears. Honing used to remove any distortion after hardening and to selectively size the gears to uniform diameters.

Cones for Wheel Balancing Machine "Accurately align hones two interrupted surfaces."

Make I machin

New WILSON "HONEY BEE" ARC CONTROL STATION

permits 2 or more welding operations from one WILSON "HORNET" GENERATOR

★ ★ ★

★ ★ ★

One Wilson "Hornet" becomes two or more times more productive when used with the new Wilson "Honey Bee" Arc Control Stations. Two or more welding operations are performed simultaneously by connecting three 75 ampere Wilson "Honey Bees" to a 200 ampere Wilson "Hornet", or four 75 ampere "Honey Bees" to a 300 ampere "Hornet". More arcs per generator are provided with a better load factor and more welding per K.W.H. of power purchased.

Wilson Arc Control Stations are made in two sizes, 75 ampere and 150 ampere for use with any constant potential arc welding generator. Any Wilson "Hornet" can be changed to constant potential by making a simple connection.

A control switch which may be combined with the electrode holder permits the operator to regulate his welding current from maximum to minimum without breaking the arc or affecting other station current settings. By gradually reducing the current the operator can avoid craters, especially important for light-gauge metal welding.

DIMENSIONS

	Height	*Length*	*Width*	*Weight*
75 ampere	20"	24¼"	11¼"	125 lbs.
150 ampere	20"	29¼"	13¼"	160 lbs.

For more complete information send for Bulletin ADW-47.

WILSON WELDER AND METALS

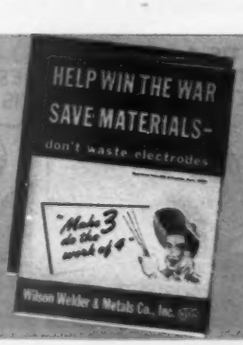
General Offices: 60 East 42nd Street, New York, N. Y.

Photo courtesy of Republic Aviation Corporation.

CO., INC.

CONSERVE WELDING ELECTRODES

Write for free copies of this helpful booklet. It contains six shop bulletins emphasizing important ways to prevent electrode waste.



The Birdmen's Perch

THE NAMES FOR OUR Canary Commando were wonderful, gang!

We wish we had a dozen Oily Boids so that we could call them "*Blunderbird*," "*One Wing Low*" and "*Rudderduck.*"

And even Oily howled at "*Luberator*" and "*PB ½.*"

He didn't seem to like "*Gasolini*" or "*Burblebird*" or "*Airacoma*"—but we did!

But the life-size portrait of Oily goes to a girl! Mary Bennett, of Engle-

wood, N.J. sent in the name we liked most...the name that most perfectly describes our 4-F Fowl.

Perch Pilots, meet "*FLUTTER,*" the Oily Boid.

Major Al Williams

alias, "Tattered Wing Tips," Gulf Aviation Products Manager, Gulf Bldg., Pittsburgh, Pa.

BRAINTWISTER

A pilot had to fly from Pittsburgh to Detroit on business. He left home in the morning accompanied by his wife, who saw him off and waited at the airport until his ship was out of sight. He flew to Detroit non-stop, and the first person to greet him was his wife. She'd not travelled by train, road, or plane. How did she get to Detroit?

When you send your post card for the answer, send us your brain-twister, too. Complete with answer, please.

SOME-DIAL!

You Perch Pilots who fly twin-engine jobs will soon find it much easier to check your instruments.

A new whingdinger of an instrument combines the readings of three instruments (2 tachometers and a synchroscope) *on one dial.* You get an rpm reading on BOTH engines and see how much out of synchronization they may be at a glance. Removing the two unnecessary dials disposes of deadweight, and the remaining dial does more work.

Lubricants refined by old-fashioned methods had parts which made sludge and parts which formed carbon—in addition to the part which did the actual lu-

bricating. To get rid of these unnecessary parts of petroleum, Gulf engineers devised the Alchlor Process, which removes *more* of these two deadweights from Gulfpride. And the remaining oil does more work.

Better try it.

POWER OF THE PRESS DEPT.

It's been some time since we felt obliged to open the musty doors of our POTP Dept.

But we'd like to remind you of a letter from "Great Circle" Gribbin, in July's Perch. Part of his whopper said, "*A while back you mentioned a tailless plane without a fuselage. It seemed like the wrong approach to a good idea. A wing is bound to contribute to drag. I tried to solve the problem of drag in a different way. I made a tailless plane without a* wing."

Now read this, from a recent newspaper:

"A wingless airplane dubbed the 'Flying Flounder' has been successfully flown more than 62 times by its inventor. The plane looks like an elliptical pancake and does 190 mph."

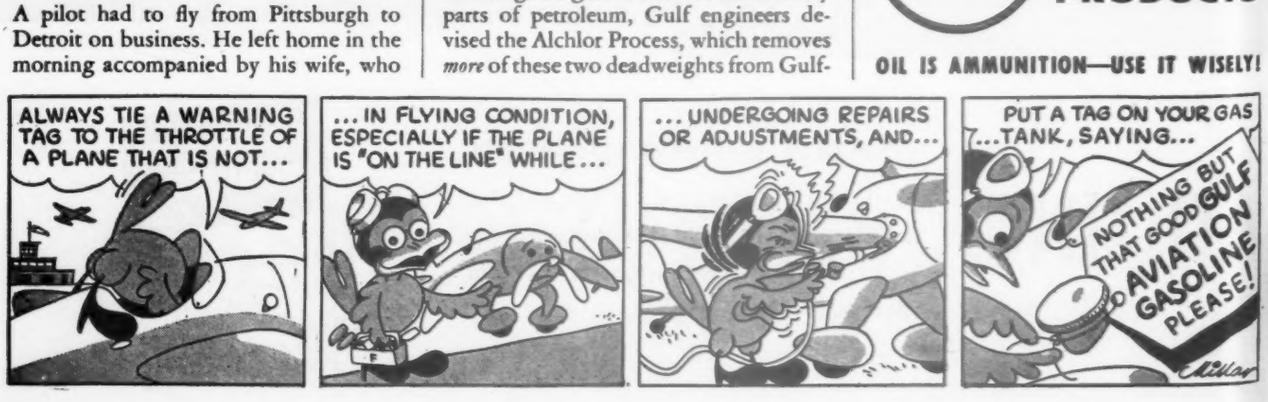
Well—?—

Bet he used Gulf Aviation Gasoline, too.

Gulf Oil Corporation and Gulf Refining Company...makers of

GULF AVIATION PRODUCTS

OIL IS AMMUNITION—USE IT WISELY!


ALWAYS TIE A WARNING TAG TO THE THROTTLE OF A PLANE THAT IS NOT...
...IN FLYING CONDITION, ESPECIALLY IF THE PLANE IS "ON THE LINE" WHILE...
...UNDERGOING REPAIRS OR ADJUSTMENTS, AND...
PUT A TAG ON YOUR GAS ...TANK, SAYING...
NOTHING BUT THAT GOOD GULF AVIATION GASOLINE PLEASE!

DoAll HELPS WRIGHT *keep tonnage flying*

• This model ML DoAll, installed in a tool room in a plant of the Wright Aeronautical Corporation, is one of many DoAlls helping to build Cyclone and Whirlwind aircraft engines for the United Nations.

Today Wright Cyclones and Whirlwinds power planes and tanks in combat and power troop transport and cargo carriers which now fly to war fronts all over the world. Tomorrow, as the tonnage loads of commerce take to the air, Wright engines will provide the power.

SPEEDS UP PRECISION METAL CUTTING

The DoAll is doing a real job in busy plants everywhere — replacing slow methods of shape cutting any kind of metal or alloy, blocks a foot or more thick, bar and sheet stock, tubing.

DOUBLES MAN-HOUR OUTPUT

That's what this master machine tool is doing for the aviation industry. Look over jobs that are going through too slowly, waiting for shaper, miller or lathe. Wherever there is internal or external cutting or filing to be done, switch the work to the DoAll and you'll be surprised at the time, labor and metal you can save.

and ON THE GROUND

The DoAll is part of the essential equipment of each mobile machine shop of the U. S. Air Corps used for servicing combat planes right on the spot.

Ask for Demonstration in your Own Plant

A factory trained man will gladly call and show you the many advantages of the DoAll, which is offered in 5 different models ranging in price from $1,000 to $5,000 complete with motors.

FREE BOOK—"DoAll on Production", a pictorial story of DoAll at work in many factories. Send for copy.

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Manufacturers of Band Saws and Band Files for DoAll Contour Machines

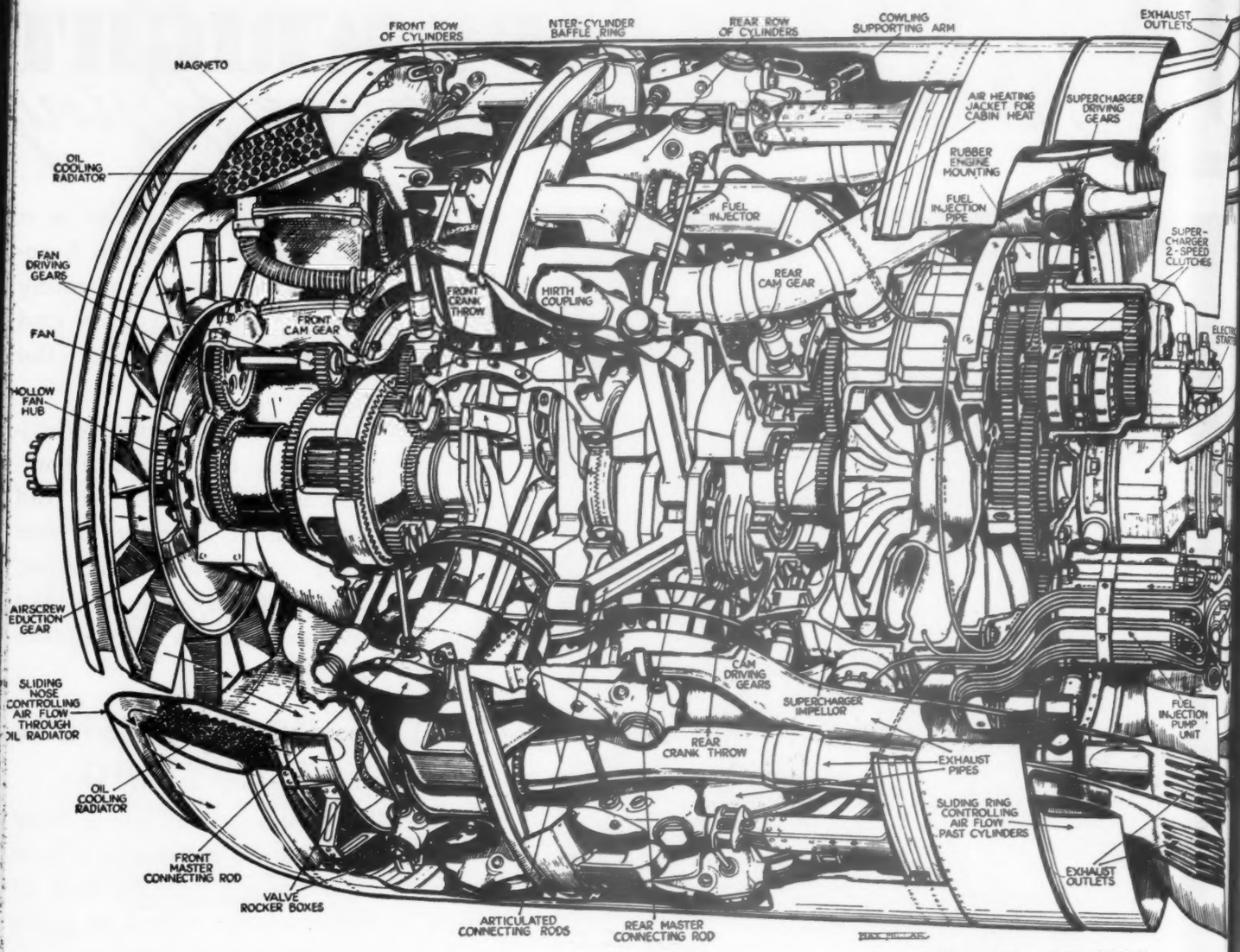


Fig. 1

Illustrations courtesy "Flight"

Design Details of The BMW-801A Engine

By MYLES V. CAVE, *"Aviation's" British Correspondent*

First-hand study by an AVIATION correspondent shows Germans have built a very fine powerplant with many interesting features, especially in cooling system.

THE BMW801A FOURTEEN cylinder twin row radial engine powering the Dornier Do217 series—and a modification of which powers the Focke-Wulf 190 fighter—represents the farthest production advance of German design in the aircooled field. An 18-cylinder model —802—developing some 2,000 hp., reported coming into production, is the only Nazi engine to better it.

In layout, conception and compactness the 801 represents a big advance in German design; it is a complete power unit housed in exceptionally close-fitting cowling. Conforming to modern Luftwaffe practice, it is a direct fuel injection engine.

The 14 cylinders are arranged in staggered positions in a triple split cast steel crankcase with the bottom cylinder of the front row and top cylinder of the rear row being vertical. Characteristic

of construction throughout the engine, no expense appears to have been spared to give the most rigid ease possible. The whole case is machined all over and, for wartime construction, is very finely finished.

The crankshaft is machined from two steel forgings, coupled in the center by a servated Hirth joint, the halves of which are threaded coarse and fine in each half of the shaft. To lock the shaft up a solid steel bush, internally splined for the assembly tool, is screwed into the threads bringing the servations on the coupling into close engagements. The outer circumference of the Hirth coupling acts as the journal for a center bearing for the crankshaft. The bearing itself is a heavy-duty single row ball bearing type, while both front and rear crankshaft bearings are of the roller type.

The crankshaft has four heavy webs with counterweight integral, the webs being drilled and lead filled for balancing.

front and rear rows of cylinders. Valve rockers run on needle bearings and are completely enclosed and pressure lubricated closely following current American practice.

A simple epicyclic gear train for driving the front valve cam ring is carried on the front end of the crankshaft in front of which is a steel drum containing the epicyclic star gearing for the propeller reduction gear.

At the front end of the drum is cut a large diameter spur gear driving a shaft which drives a geared sleeve on the crankshaft center line. This sleeve is flanged forward of the gear teeth and bolted to a corresponding flange on the rear of the cooling fan thus forming a drive for the fan.

From the fan drive gears is taken the drive for the Twin Bosch type Z.M.14 magnetos. Both magnetos are vertical mounted on the aluminum alloy front casing.

Unusual Cooling Fan Used

The cooling fan is mounted directly behind the screwed and splined propeller shaft. Slightly to the rear of the fan and located circumferentially in the forward part of the cowling is the spe-

(*Turn to page* 291)

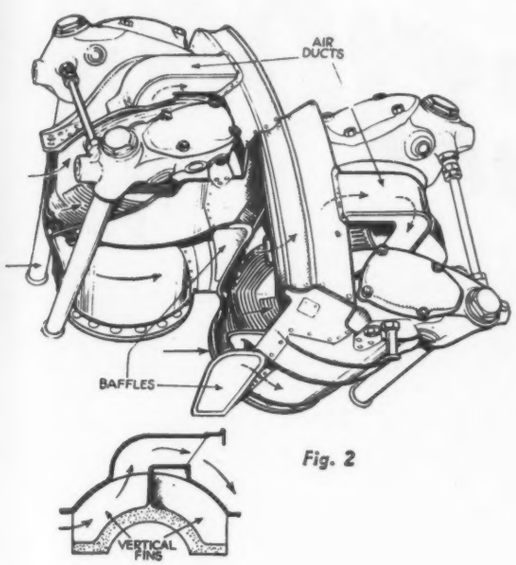
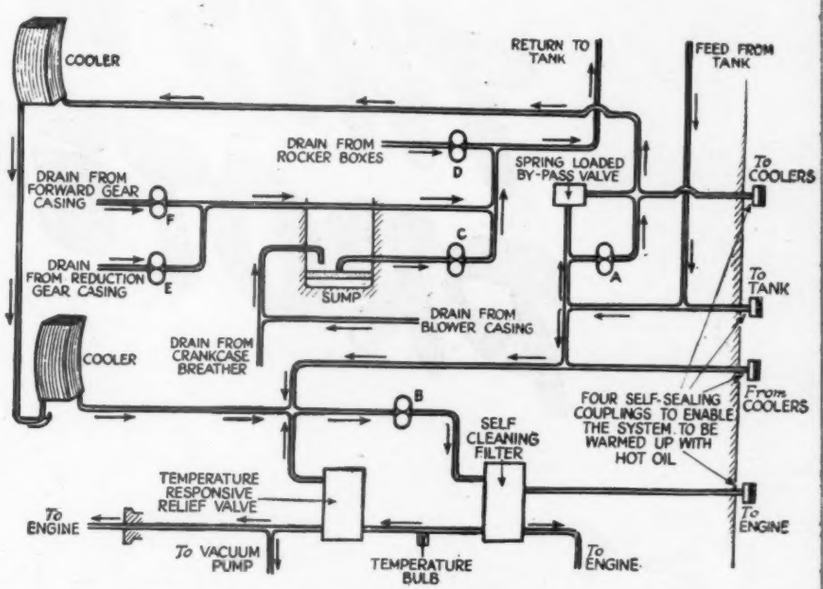


Fig. 2



Layout of the lubricating system of the BMW-801A. Pumps A and B are pressure pumps for delivery, while pumps C, D, E and F are scavenging pumps.

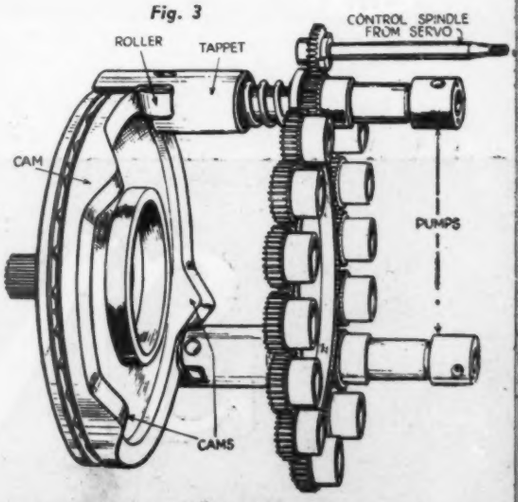
Master connecting rods are located in the low port cylinder in both front and rear rows. Connecting rod bearings are steel, lead-bronze lined.

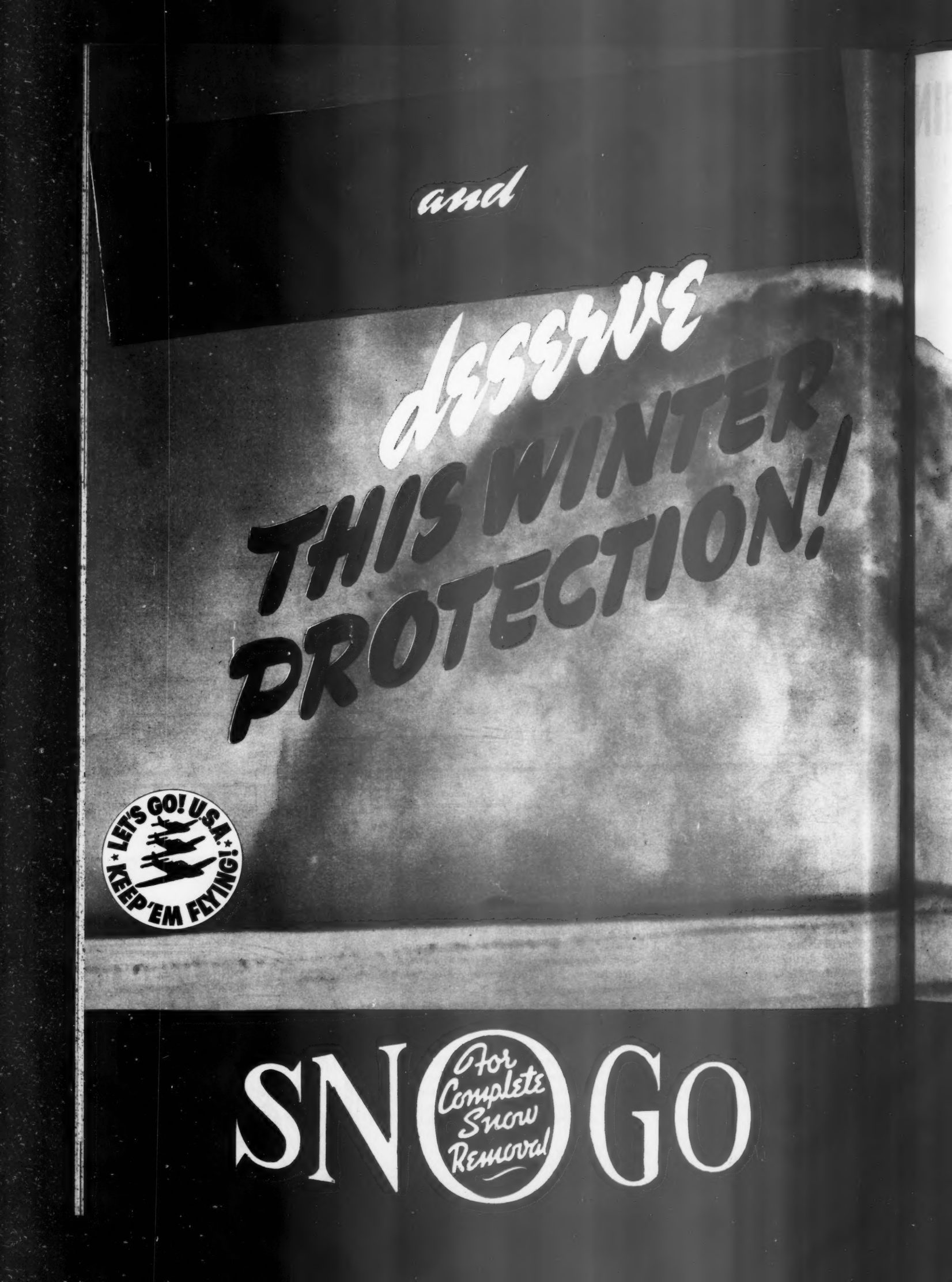
The steel cylinder barrels are closely finned, and at the base of each there is a thick flange drilled circumferentially for the retaining studs fixed in the crankcase. Cylinder heads are of aluminum alloy and appear to be screwed and shrunk to the steel cylinder. Each head has two large diameter valves—one inlet and one exhaust, the latter having a hollow stem and is sodium cooled.

Valves are operated by push-rods from circular cam rings located at the front and rear of the engine, each series of cams operating the valves on the

FIG. 1. Cut-away drawing of the BMW-801A 14-cylinder radial engine which represents greatest German advance in the aircooled field. A power-driven fan together with extensive baffling provides adequate cooling with unusually close fitting cowling. Note the oil radiator in the nose of the cowling and the reverse flow of air through it . . . FIG. 2. Detail illustrating part of the baffling and air ducts employed to direct cooling air to both front and rear cylinders of the BMW-801A . . . FIG. 3. Section showing concentric arrangement of fuel injection pump plungers around the circumferential gear ring which forms the master control for all pumping elements.

Fig. 3




and
deserve
THIS WINTER
PROTECTION!
LET'S GO! U.S.A.
KEEP 'EM FLYING!
SNO GO
For Complete Snow Removal

FOR years commercial flying has gone on taking "a business chance" on snow in spite of the fact that adequate snow removal equipment was available. Commercial flying has been willing to risk business loss due to snow-grounded ships, not knowing in many cases what snow has cost them. The Military Services have appreciated the fact that high priced lives and high priced ships deserve proper winter protection. Military airports are Snogo protected.

Some day a peace treaty is going to be signed and commercial and private flying is coming into its own, and inability to meet transport schedules because the runway is littered with snow isn't going to be considered good business.

Thoroughly modern flying fields will advance the cause of flying by being Snogo equipped.

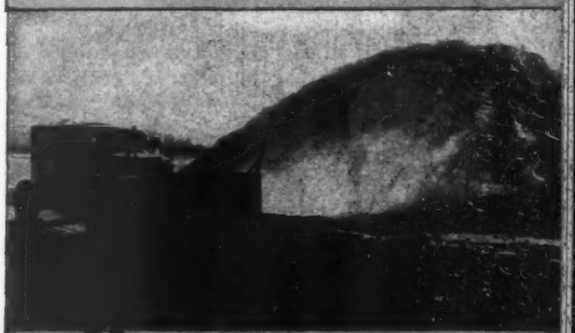
Remember, Snogo makes winter flying safer. It throws the snow *off* the runway. No banks are built up to drift back on the runways or endanger wing tips. There is no costly repeat plowing. There is no heavy layer of packed snow to freeze into dangerous ruts or partially thaw into mushy spots and provide slush to be picked up in wheel pants, freeze brakes or be carried into wheel wells.

Snogo can be your insurance that winter schedules will be met. Aviation men and air-minded travelers should insist that airports have better winter protection.

KLAUER MANUFACTURING COMPANY,
Dubuque, Iowa

It is seldom a field has drifts like this but when you do, Snogo can handle it.

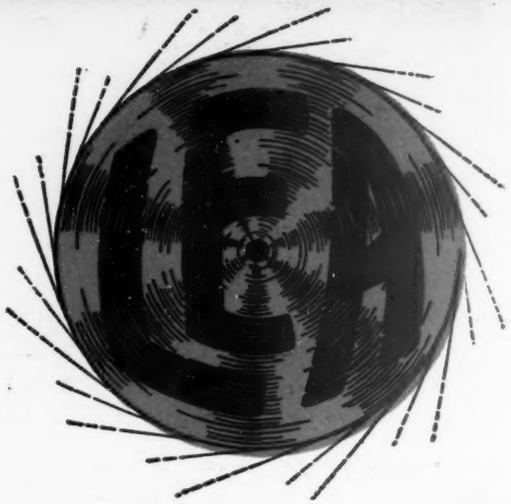
Look at that throw! There won't be any banks piled up to cause trouble and drifting here.



It is sometimes desirable to windrow snow and then throw it into the unused area.

POSITIVELY GUARANTEED to handle any snow conditions that will ever occur on any Airport!

SNOGO keeps 'em flying in any WINTER WEATHER!

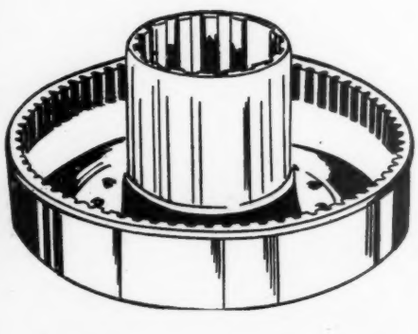


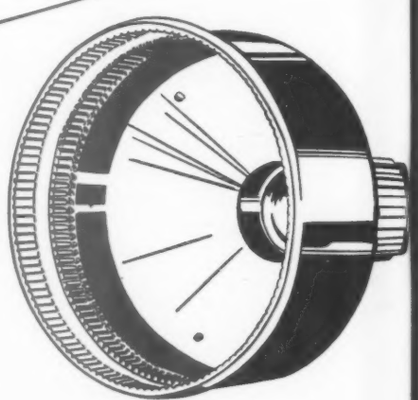
BURRING AND POLISHIN METHODS

CUT COSTS

REDUCE REJECTIONS

INCREASE PRECISIO





Burring is actually polishing, for polishing really means "removal of the surplus metal, plastic, or wood". Therein, lies the underlying reason why Lea Technicians have been able to help so many war industries with their burring operations. Lea Technicians have long been recognized throughout industry—metal and non-metal—as specialists in polishing, buffing and finishing in the removal of metal to provide decorative finishes. They are applying their knowledge and experience to burring problems.

The Lea Method of Burring cuts costs, reduces rejections, and increases precision. It does away with many costly and time-consuming operations calling for hand tools, emery cloth, or hand filing. Instead, it uses specially designed bobs or wheels coated with the proper Lea Composition.

Every day new burring—and polishing—problems are brought to our attention. With most of them, we have shown the manufacturer how to improve his operations. Send us your problem for our recommendations. If possible, send a sample of the work.

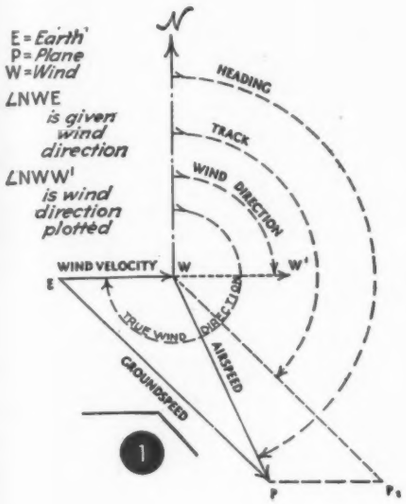
THE LEA MANUFACTURING CO.

WATERBURY, CONN.

Burring, Buffing and Polishing. . . . Specialists in the Development of Production Methods and Compositions

Wide range of problems can be handled by new devices but thorough understanding of basic principles is required.

Simplified Computers Aid Navigation



By LIEUT. COMDR. P. V. H. WEEMS

INDOCTRINATING new pilots, especially in the ground school sciences, is a problem that must be handled with minimum effort and mass efficiency. In many of the branches there is no substitute for long hours of study but in some phases of air navigation recent developments have opened a number of ways to shorten the problem.

The many dead reckoning problems, most of which can be handled on a flight computer, fall in this category.

Flight computers in themselves must not be considered simplifiers or "magic brains." The underlying principles must be thoroughly mastered and the student must learn to recognize each problem type before setting it up on the computer's face. These principles, however, are not difficult if they are acquired in a step-by-step procedure with the standard phraseology used by the services.

Every dead reckoning problem involving wind or drift is made up on a basic figure called the velocity triangle. This triangle is made up of the values shown in Fig. 1. The designations E, W, and P are as follows:

E → W = wind speed and direction
E → P = ground speed and track
W → P = Airspeed and heading

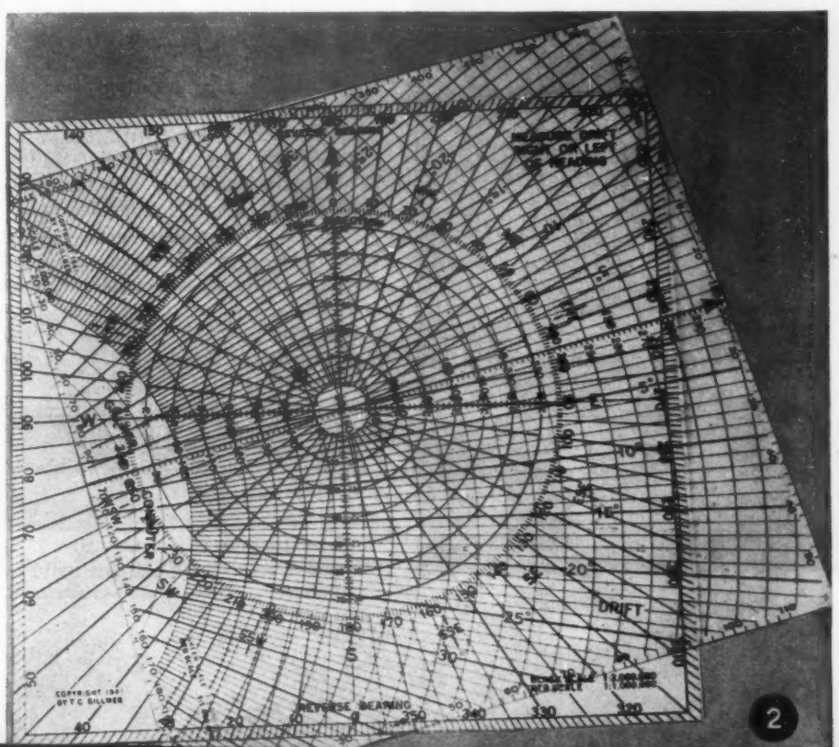
The letter combination is self-explanatory in that E stands for earth; W for wind; and P for plane. E→W then implies wind relative to the earth or its true speed and direction. E→P likewise signifies the planes motion relative to the earth, or ground speed and track; and W→P, the planes motion relative to the wind, or airspeed and heading.

In using them to lay out the velocity triangle it is extremely important not to reverse their order. For example, the heading and airspeed can only be W→P and not P→W. The best practice is to work from the point W and establish an airspeed circle which in most cases is a known value. Now, with these principles in mind we can apply the solution to flight computers. While most computers vary in appearance they are similar in operative principle. Their cost is in direct proportion to the precision of manufacture and number of moving parts required.

The great majority of calculators consists of a series of disks pivoted on a common center. On one side of this assembly is usually found the speed, time, distance, and fuel calculator. The most common form is that of a circular slide rule and in all cases is of such simple form as to be self-explanatory. It must always be remembered that the 60 mark on the time scale is the speed index. In conjunction with this speed and distance side is also usually found an airspeed corrective. This, of course, is of great importance in correcting the indicated airspeed to true by taking the air temperature into consideration against the "pressure altitude."

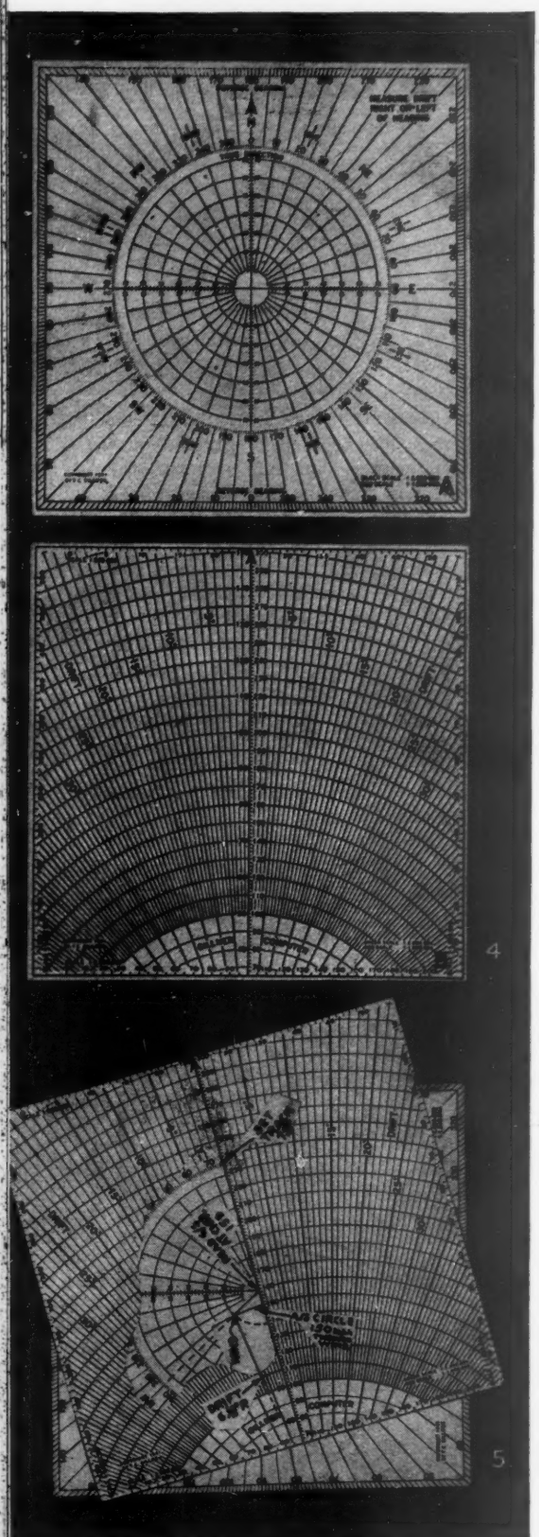
The opposite side of the computer consists of the moving disks and plates required to solve the velocity triangle.

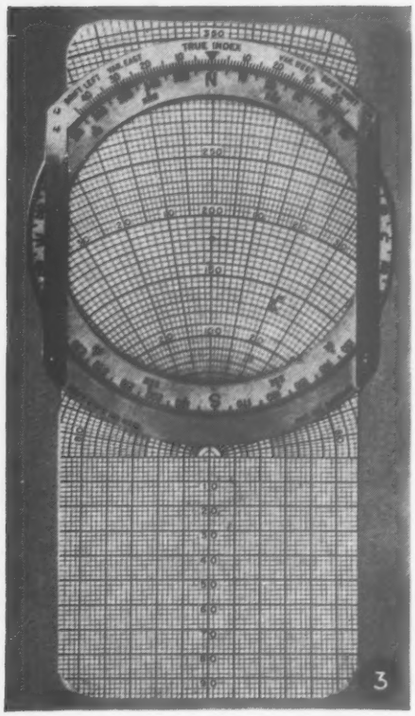
Perhaps the simplest form of such



computer, yet one that embodies exactly the same principles and theory as the most precise computer used by the Army, is the recently developed Gillmer Computer shown in Fig. 2.

This computer is especially adapted for training new students, because of its wide and well-distributed scales. It has an extensive speed range and reads to every degree of drift and heading. It is also inexpensive—costing about one-tenth as much as the Army model J—primarily because of the lack of moving parts. (Fig. 3). Use of the Gillmer Computer by Army ground schools or pre-flight classes will release many needed model J's to fighting planes.





To become familiar with the basic principles of all computers we can do no better than study this simpler two-piece Gillmer Computer. It is composed of two plates A & B, as shown in Fig. 4, one movable on the other. Plate "A" can be called the bearing circle, or wind grid, and Plate "B", the drift grid.

On Plate "A" the radial lines denote true directions for locating wind, heading or track. The concentric circles are wind velocity circles with the velocity shown along the North South and East West lines. There are two scales: red, 1:1,000,000; black, 1:2,000,000.

Plate B, or the drift grid, is a grid wherein the arcs are arcs of speed circles and the radial lines denote the degrees of drift from a point centered "off" the plate. The speed scales are arranged along the center line or course arrow for each arc of the speed circles.

To use the computer two rules must be remembered:

1. When *Track* is known locate wind (on Plate A) in quadrant it is from,
2. When *Heading* is known locate wind in quadrant it is toward.

Remember also the old rule "add drift right." Let us go through a typical solution:

EXAMPLE I: To Find Heading and Ground Speed for a given Track and Airspeed.

Given:
Wind, 20 mph. from NW.
Track to be made good, 75 deg. (T).
Airspeed, 150 mph.

(*Note:* Use black and green scales.)

Procedure: (Fig. 5) Locate wind by pencil mark in quadrant it is blowing from (see Rule 1 above) on 20-mi. wind circle on NW bearing. Place Plate B on top of Plate A with course arrow (center line of Plate B) through center of compass rose on Plate A and through 75 deg. (Track). Keeping plates thus aligned, move in or out until the 150 (A/S) speed circle falls over the penciled wind mark of Plate A. Now read 6½ deg. drift from the drift lines through the same wind mark and read the ground speed at the center of the compass rose, 159 mph. The drift (6½ deg.) is between the Heading (drift line through wind) and the Track. Drift is always named right or left of heading. In this case it is 6½ deg. right drift and is subtracted from track to obtain heading thus; heading=75—6½=68½ (T).

Remember: Airspeed is always measured along heading. Ground speed is always measured along track.

A second example will serve to show the valuable type solution.

EXAMPLE II: To Find Track and Ground Speed for a Given Heading and Airspeed.

Given:
Wind, 20 mph. from NW.
Heading, 330 deg. (T).
Airspeed, 105 mph.

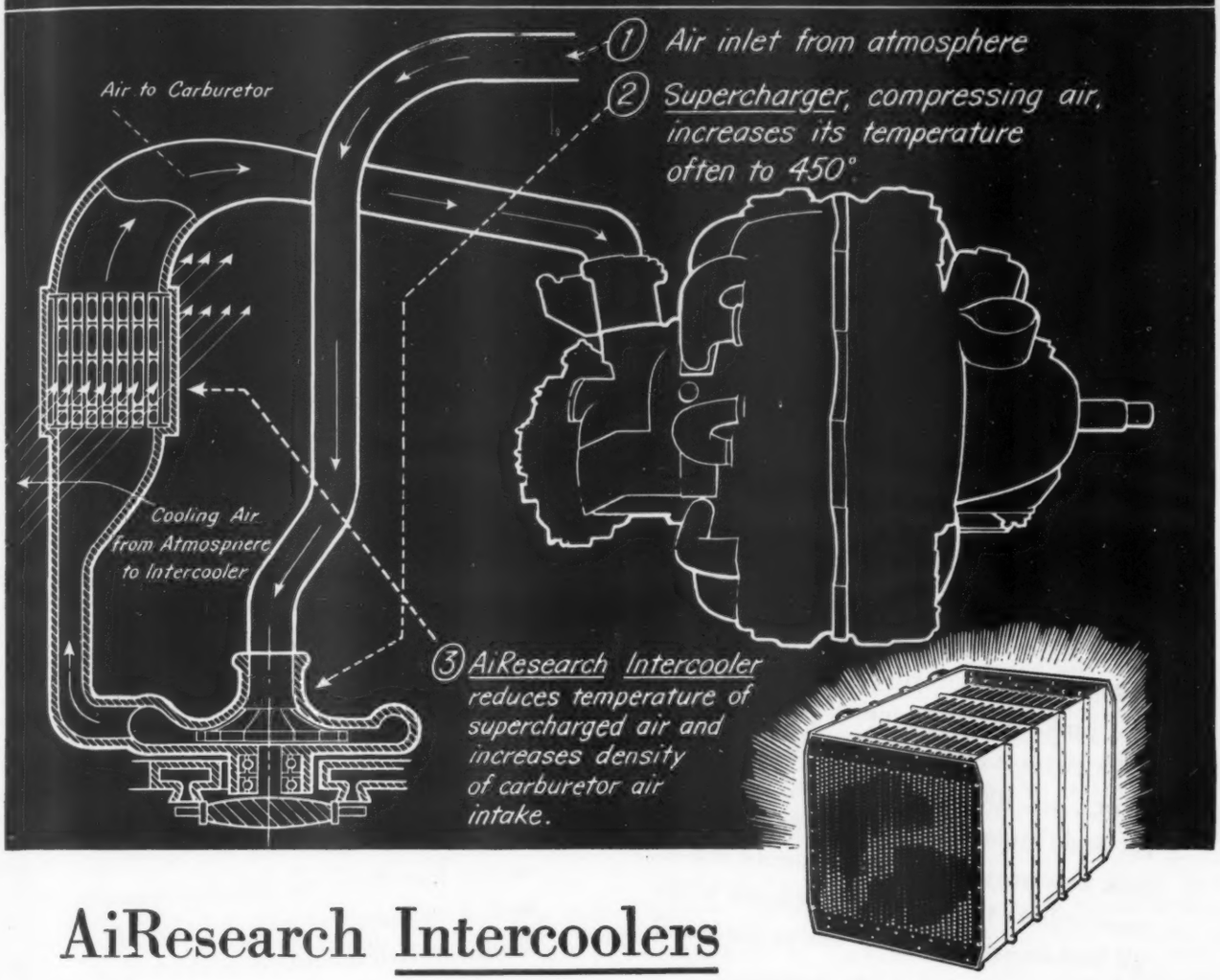
(*Note:* Use red scales.)

Procedure: Locate wind in quadrant it is blowing toward (see Rule 2 above). Wind circle 20 and reverse bearing 315 (NW). Place Plate B on Plate A with course arrow at the center of the compass rose. Now over the wind dot read the speed circle 86 mph. and the drift 3½ deg. Right. Track is then 333½.

The computer is not limited to ordinary drift triangles. Radius of action, double drift problems, off course and, finally, interception problems are all handled in the standard manner.

While these problems involve complicated figuring beyond the scope of this article, they are basic dead reckoning problems involving the same triangle of velocities set forth at the outset of the discussion. Fundamentally, that is all that any computer consists of—simply infinite combinations of the velocity triangle. It is the pilot-navigator's problem to "fix" the set-up to his own particular triangle.

UP goes the airplane's critical altitude...


1 Air inlet from atmosphere
2 Supercharger, compressing air, increases its temperature often to 450°
Air to Carburetor
Cooling Air from Atmosphere to Intercooler
3 AiResearch Intercooler reduces temperature of supercharged air and increases density of carburetor air intake.

AiResearch Intercoolers

help U. S. engines get *more* from their superchargers

The extreme heat of supercharged air causes detonation, reduces engine efficiency. It decreases the weight of the mixture delivered to the engine—thus reducing the critical altitude of the power plant.

To improve the control of supercharged air temperatures, our engineers developed the AiResearch Intercooler. Thoroughly test-proven in AiResearch laboratories, these Intercoolers are now in use in thousands of American airplanes...helping their power plants deliver *added useable power at critical altitudes.*

The AiResearch Intercooler is very *light in weight.* It is manufactured of heat-treated aluminum alloys. The entire assembly is anodized for protection against corrosion. Tubes are mechanically fastened and are jig-assembled to assure ruggedness.

More than 40,000 *hours of service* have proven this Intercooler's freedom from maintenance trouble.

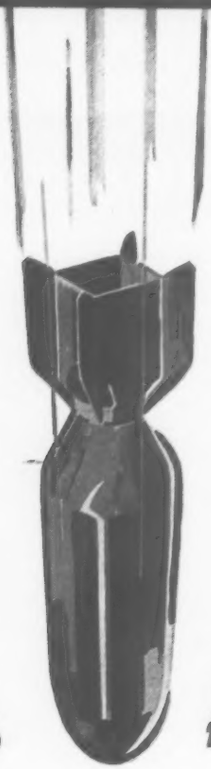
AiResearch Intercoolers offer utmost flexibility. They are available in flattened or round tubular units. Tests of tube spacing and arrangements prove their adaptability to varied requirements of shape and size.

Aircraft manufacturers interested in the advantages of these Intercoolers are invited to write or wire for details.

AiResearch
MANUFACTURING COMPANY
LOS ANGELES, CALIFORNIA
DIVISION OF THE GARRETT CORPORATION

"Where Controlled Air Does The Job" • Engine Oil Cooling Systems • Engine Coolant Systems
Automatic Exit Flap Control Systems • Supercharger Aftercooling Systems

HOW THE AVIATION INDUSTRY CAN FURNISH BOMBS AS WELL AS PLANES



THERE'S a bomb in your cellar or attic. No, it doesn't look like a bomb. Right now it's broken garden tools . . . discarded toys . . . worn-out pots and pans . . . junk. But every piece of scrap will make twice its weight in fighting equipment . . . 100 pounds of scrap will furnish basic metal for a bomb big enough to sink a destroyer. Get those bombs out of your cellars today, and the planes we're all building will deliver 'em to the Axis!

When You Quit Work Today, Do This

If you live at home, get busy and collect all the scrap you can find. You'll be surprised to see just how much you have on hand. Then call a junk dealer, or your local scrap collection agency. If you don't know where to get in touch with the scrap collection agency, call your local newspaper and they'll tell you.

If you live in a boarding house or apartment, team up with the other folks in the house. Offer to do a clean-up job for the householder and dig out all the scrap.

If you have folks back home, write today and tell them to get their scrap into action . . . *quick!* America must have scrap!

What the Aircraft Industry Can Do

Employment figures for the industry are secret. But there are certainly upward of half a million employed. And if each family of half a million aircraft workers were to collect the national family average of 104 pounds of scrap, it would add 50 million or more pounds to our war effort . . . enough to blast Hitler, Tojo and Mussolini straight to hell. And the only cost is an hour or so of our time! That's not asking much when we know what our friends, brothers, sons and husbands are up against *out there.*

How about it, aircraft men and women? Let's stop "letting George do it." Let's do it ourselves . . . TODAY!

Published in the interests of the National Scrap Salvage Drive by The Glenn L. Martin Co., Baltimore.

POWER TURRET SPECIALISTS

Power turrets for America's bombers are studied by Army Air Forces technicians at Briggs Manufacturing Company's AAF Training School just prior to graduation of first class. Living, class and recreational facilities are all located in plant in which Briggs first began building power turrets. Production program has expanded so much that an entirely new plant was built.

Civil Patrol Reorganizes

Civil Air Patrol has been streamlining its Wing organizations for better efficiency. Group Commands, which became an unnecessary layer of organization in most states, are being telescoped into the Squadrons. Last May there were 287 Groups in the country; that number had been cut to about 200 by the end of August and now is about 150. At least 18 states have eliminated the Groups entirely so the Squadrons report directly to Wing Headquarters. This does not mean, however, that CAP is dwindling.

Prior to June, when non-flyers were no longer approved for membership unless endorsed by local unit commanders, there were about 200 applications a day. The change in policy cut this figure in half. Over the past four months, they have came in with only minor variations at the rate of 100 per day; enough to outweigh losses in membership.

ON PATROL . . .

• CAP headquarters announced formation of Civil Air Patrol Cadet Corps, whereby each member of CAP may sponsor a junior member who is at least in next to last year of high school to give training up to the time of eligibility for full Patrol membership . . . Pittsburgh's Squadron is training to give volunteer duty in servicing Army planes landing in the area; Army personnel is adequate for most occasions, but CAP will stand by to lend trained helping hand in event of unusual number of planes coming in . . . St. Louis' Squadron is starting parachute training program under Flight Officer Joseph Ofstein. Participants will drop objects on targets to simulate conditions which might be met in getting food, clothing, medicine or other necessities to people in isolated areas . . . Oklahoma Wing mustered more than 100 planes to cover the state's 53 counties in aerial search for scrap metal . . . Syracuse, N. Y., groups, participating in a big Labor Day show, gave free rides to purchasers of $50 War Bonds—being responsible for sale of nearly $10,000 worth . . . Michigan Wing has dedicated its own field which was developed by volunteer Patrol labor . . . Baltimore, Md., units are doing the same thing to guarantee flying for those grounded in restricted areas . . . Massachusetts' Wing is establishing a courier service station outside the restricted area . . . Willoughby, Ohio, Squadron recently put on a night flying exercise in which 40 members using 16 planes made 175 landings by 3 a.m. . . . Georgia members are credited with another CAP rescue by locating a party lost off the coast; . . . the CAP pilots led the Coast Guardsmen to the stricken vessel.

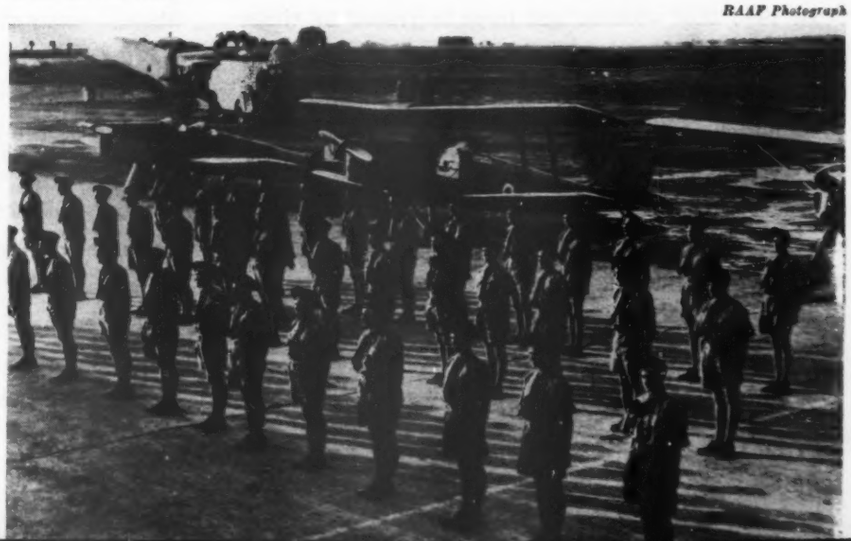
ALONG THE APRON . . .

• Latest graduating class of RAF cadets at Riddle-McKay Aero College matched a no-washout record set only once before, when all members of the class received their wings . . . New York University has a class of 25—including 7 women—in training as aircraft procurement inspectors for service with the AAF . . . similar courses are getting under way at Drexel Institute, North Carolina State, Rensselaer Polytechnic Institute and Stevens Institute of Technology . . . Hawthorne School of Aeronautics has completed its first year of training fledgling pilots for the Army; more than 3,500,000 mi. were flown with but one minor accident.

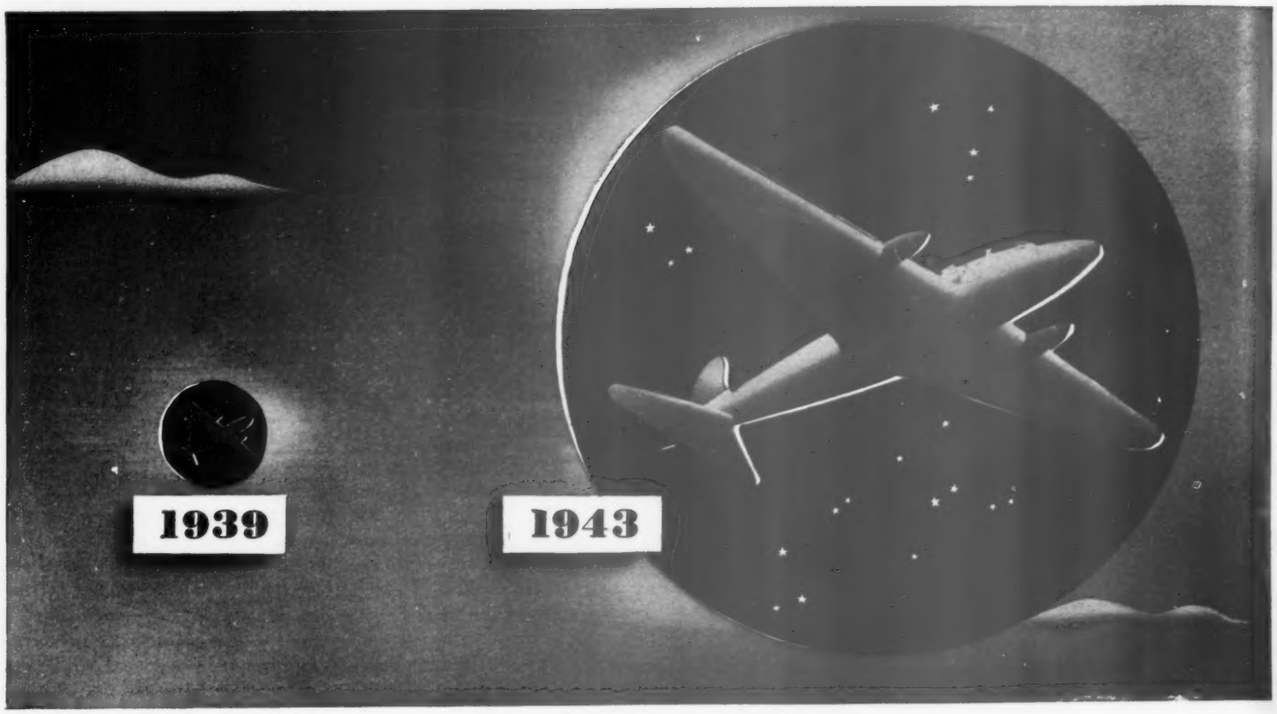
CADETS "DOWN UNDER"

Members of an Australian Air Training Corps squadron stand inspection at a base "down under." Like youths of 16 to 18 in Britain, Canada, New Zealand and Rhodesia, they are taking preliminary aviation training in navigation, radio, aircraft identification and kindred subjects which will save valuable time when they reach the required age for enlistment in the Royal Australian Air Force.

RAAF Photograph



This is the growth of the



It is likewise an excellent forecast of the promise this great undeveloped medium of transportation offers to American Industry

THAT little circle at the left above represents the value of products manufactured by the aviation industry in 1939—$250,000,000.

In 1943 that volume will have increased 36 times over to the staggering figure of $9,000,000,000.

The sheer statistics of aviation's growth tax the imagination. An industry employing a relative handful of men in 1939, aviation will next year keep a million and a half workers busy. Even in its high-production years our giant peacetime automotive industry employed but one-third that many.

But the war has done more than bring us this huge market of today.

War has shown us that we've just scratched the surface possibilities of the airplane's utility. Yes, we've used it to carry perishable and rush products by air express. Air mail and air travel have grown steadily, though many still regard them as luxuries. But the big payload—*freight*—still went by train, by truck and by boat at the beginning of the war.

Now we are beginning to see the clear outlines of air transport taking shape in its ultimate form. Huge airliners will be able to carry first-class mail *at no increase in rates* and air cargo-carriers will handle freight-car loads *at freight-car rates,* time considered.

The possibilities of air transport are limited only by our imagination and resourcefulness in using this remarkably flexible method of transportation.

Aviation Industry in 5 short years . . .

Obviously the time to establish your position in this coming field of commercial opportunity is now.

The method of sales communication has long since been well established.

26 years ago a magazine called *Aviation* and *Aeronautical Engineering* hung out its publishing shingle. It traveled with the industry through its long years of pioneering and experimentation, its successes and its failures.

For the men who guided and built the aeronautical industry *Aviation* has been since 1916 the effective vehicle of communication.

Today the serious-purposed men of the industry depend on the authoritative editorial pages of *Aviation* to bring them the up-to-the-minute information on production, design and engineering advancements, the significant developments in military and civil aviation both here and abroad, the news of the industry *in proper perspective.*

The men who are building our air power today and who will build our air commerce tomorrow, look to *Aviation* as a feet-on-the-ground aeronautical industry publication—sans romance or glamor.

Aviation is edited for and read by the influential men of the industry, the men who can say yes-or-no, the only group you are interested in reaching through your advertising.

Here are just two of many examples of *Aviation's* editorial influence among the men who are the buying power of the industry . . .

Example I—When *Aviation's* editors recently uncovered the story of a revolutionary new method of forming metal sheets in huge sizes, a flood of mail poured in from busy engineers and production men . . ."Tell us more."

Example II—A recent letter-survey to top aeronautical manufacturing executives disclosed that better than 3 of every 4 not only read *Aviation* regularly but find it useful in their daily work. The letter went only to the highest ranking men in 100 aircraft, engine and propeller plants — presidents, chief engineers, general managers, production managers, purchasing agents, etc., *no one below the rank of department head.*

Aviation aims its editorial content, its circulation effort at the buying power of the industry—not the armies of workers and flying fans.

That is why *Aviation* today leads all other aeronautical publications in advertising gains.

AVIATION'S LATEST MARKET FACTS . . . just off the press

This 72-page booklet, an invaluable file of Aviation Market and Media Information is now available to you. Designed for sales-planners, it's a comprehensive picture of the market today, a glimpse into the market tomorrow. Complete editorial, circulation and advertising information on AVIATION. A request on your business letterhead will bring your copy promptly, without cost or obligation.

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A McGraw-Hill Publication • 330 West 42nd Street, New York, N. Y.

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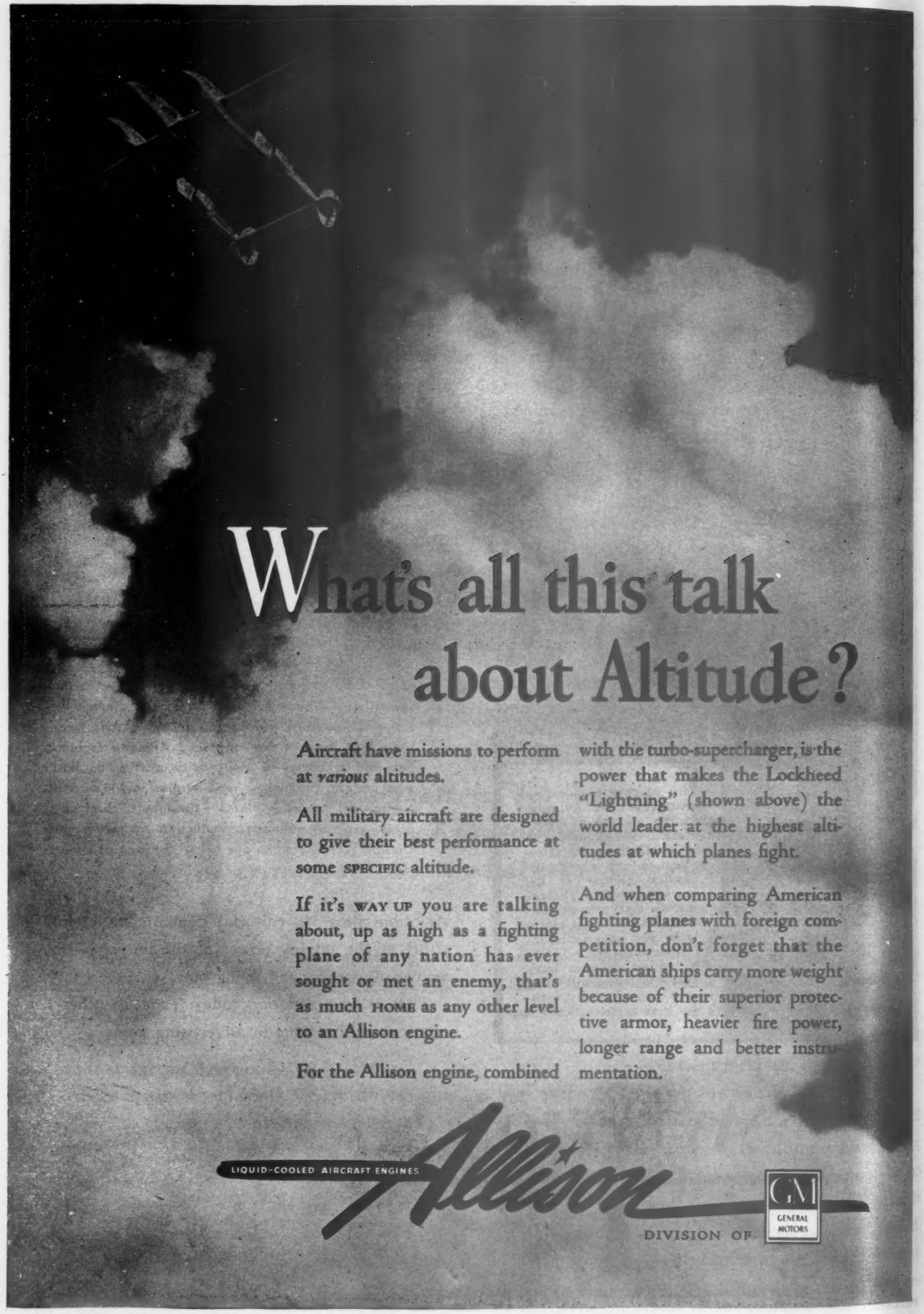

What's all this talk about Altitude?
Aircraft have missions to perform at *various* altitudes.
All military aircraft are designed to give their best performance at some SPECIFIC altitude.
If it's WAY UP you are talking about, up as high as a fighting plane of any nation has ever sought or met an enemy, that's as much HOME as any other level to an Allison engine.
For the Allison engine, combined with the turbo-supercharger, is the power that makes the Lockheed "Lightning" (shown above) the world leader at the highest altitudes at which planes fight.
And when comparing American fighting planes with foreign competition, don't forget that the American ships carry more weight because of their superior protective armor, heavier fire power, longer range and better instrumentation.
LIQUID-COOLED AIRCRAFT ENGINES
Allison
DIVISION OF
GM
GENERAL MOTORS

BORING HOLES in tubular steel airplane engine mounts is high speed, gruelling work—but heavy duty Black & Decker ⅝" Drills do it continuously, 3 shifts a day. While waiting for special machine tools, the operator of this plant reports that B & D Drills saved 3 to 4 months in starting production, and were so satisfactory that they are being used permanently.

These Tools

get 'em in the Air . . and keep 'em There

FACTORY ACCURACY in grinding motor valves for airplanes is mandatory in plane maintenance and service shops all over the globe. Black & Decker Valve Refacers produce an absolutely smooth surface on the valve face . . . just one of many ways B & D Tools help keep 'em in the air.

AFTER HEAT AND PRESSURE are applied to plastic airplane wing, fast, smooth sanding is required—and obtained with heavy duty Black & Decker Sander. In all kinds of materials—steel, wood, plastics—Black & Decker Tools are helping speed the output of America's mighty air fleet.

FROM the plants that build America's daring fighter craft to the assembly lines of giant cargo ships . . . on engine mounts of trainer planes and wing frames of dive bombers . . . in service and maintenance shops the Allied-world over . . . *more Black & Decker Portable Electric Tools are in use* — drilling, driving screws, setting studs, grinding, sanding, metal cutting—*than any others in wartime industry.*

Because Black & Decker Tools answer the aircraft industry's first law —*do the job faster*—they are first choice when the going's tough and schedules "impossible." They get first call from the men who want a power tool that "feels right," is husky enough to "take it" at top speed 'round the clock. And whether they are called upon to work in metal, wood or a dozen different plastics, it's all the same to B & D Tools . . . they "produce" with high speed precision regardless of the job.

HELP . . . in a HURRY! *If you have a production problem stumping you, get in touch with your nearby Black & Decker Distributor. He's dependable, convenient—as a source of supply or a "tool information" expert. The Black & Decker Mfg. Co., 738 Pennsylvania Ave., Towson, Maryland.*

Get in the Scrap with Your Scrap!

LEADING DISTRIBUTORS EVERYWHERE SELL

Black & Decker

PORTABLE ELECTRIC TOOLS

PROPELLERS *over the* ATLANTIC

Streaming through the skies above the Atlantic, the U. S. Army's Air Transport Command is piling up a brilliant record in delivering hundreds of Boeing, Consolidated, and Lockheed bombers to Britain.

In millions of miles of trans-ocean operations no pilot has ever had to worry about his propellers. All of these bombers have been equipped with dependable Hamilton Standard Hydromatic propellers.

HAMILTON STANDARD PROPELLERS

One of the three divisions of

UNITED AIRCRAFT CORPORATION, EAST HARTFORD, CONN.

HAMILTON STANDARD EAST HARTFORD CONNECT. DIVISION OF UNITED AIRCRAFT CORPORATION PROPELLERS

The AVIATION NEWS

BLAINE STUBBLEFIELD, Washington C. B. F. MACAULEY, New York E. EUGENE MILLER, New York JOHN FOSTER, JR., New York

War Labor Board to Establish Pacific Wage Stabilization Committee

A Pacific Coast Aircraft Stabilization Committee will be set up by the War Labor Board, as a result of data presented at a hearing held in Los Angeles Oct. 12 to 17. The committee, to be recommended by Chairman Paul R. Porter, WPB stabilization expert who conducted the hearings for the WLB, will be composed of management and labor representatives, Army and Navy observers, and a WLB chairman. It will have WLB authority to make minor changes, within the limitations imposed by Executive Order 9,250 and WLB policies.

Evidence supporting contentions of widely varying labor supply, living costs, and other factors, was conclusive and indicated the impracticability of attempting to set uniform wage rates for large sections of the nation. Higher living costs at Seattle and competition from shipbuilding yards for labor, were cited by the Boeing Aircraft Co. in its recommendation that for its area a 95c. an hour wage rate be established for beginners. That would increase to $1.50 the maximum for skilled workers.

Southern California's eight plants recommended a starting rate of 80c., but gave out no top figure. Labor representatives of the AFL and CIO, and the independent National Union of United Welders advocated a 95c. minimum and $1.65 maximum.

Management and labor agreed that personnel turnover, caused by migration to other areas, to shipyards, and to the armed services, is a serious problem. Boeing presented figures showing a turnover of 94.8 percent during the past nine months. However, management contended that solution of the problem will not be achieved by merely increasing wages. What other methods it felt would be necessary it did not say publicly.

Management, which had been dealing with labor of individual companies, after three days of negotiations, presented a united front for the first time in its history. Labor immediately began maneuvers for a joint committee to represent its three groups in all dealings with management. When the Boeing report was read into the record Friday, labor representatives seized upon it as evidence of a split. However, it was pointed out that the Boeing recommendation of 95c. an hour starting pay merely meets that being paid in its territory by shipyards, and its $1.50 per hr. top is 15c. less than that asked by the unions.

The Boeing report stressed the fact that living costs are higher in its area. And it was pointed out, with a smaller labor reservoir, its shipyard competition already provides employment to more than 2½ times as many workers, while in the Los Angeles area, with a larger labor reservoir, aircrafters outnumber shipbuilders by about the same ratio.

Union representatives contended that higher wages paid aircrafters in other sections of the country are causing heavy migrations of labor from the Pacific Coast plants. They cited rates of $1.13 at Willow Run; $1.10 in Detroit; 98c. in the Buffalo area; and 84.9c. along the East Coast as compared to the California average of 83.9c. an hour.

Chairman Porter stated that the information obtained during the hearing had been willingly given and was the most complete yet received by the WLB. He will prepare it for presentation to the WLB and will also make a recommendation on whether or not wage increases should be granted, if asked to do so. The WLB is expected to render its verdict within two months and it is predicted that labor will accept its decision willingly, even if it does not go beyond the recommendations made by management.

The Stabilization Committee which Chairman Porter will recommend is expected to become a pattern for similar committees in other sections of the nation for the aircraft industry and, later on, for other war industries. One of the goals that appointment of such committees will achieve is decentralization of the activities of the War Labor Board. Sectional or regional committees, it is believed, can pass on future problems with better understanding of conditions and do so more quickly.

Management representatives of the Pacific Coast plants, at the Los Angeles hearing, were W. G. Tuttle, Vultee, chairman; E. R. Perry, Boeing; A. M. Rochlen, Douglas; W. F. Pearson, Consolidated; R. Randall Irwin, Lockheed-Vega; M. E. Deaman, North American; Walter Gates, Northrup, and G. O. Adams, Ryan.

CIO representatives were Richard T. Frankensteen, James Wishart, Lew Michener, and William B. Taylor. AFL representatives were Dale O. Reed, Roy Brown, and Gary Cotton. The independent NUUW was represented by Donald T. Ketchum. Chairman Porter was assisted by H. Arnold Tolles of the WLB.

Set Tube Standards

About 60,000,000 ft. of steel tubing will be needed for engine and gun mounts, landing gears, fuselage structure, hydraulic cylinders, many stressed parts, and jigs to complete the air war program.

The airplane manufacturers' standardization body, the National Aircraft Standards Committee, is cooperating with the Army, Navy and WPB in developing a list of standard steel tube sizes which will help aircraft manufacturers increase production. The office of the national chairman of the NASC is maintained at Washington by the Aero Chamber of Commerce.

U. S. and Britain in Standards Progress

Steady progress is being made toward standardization of accessories by United States armed forces and by the British on American-made planes. Testimony before Congress recently revealed that the British are still using their own radio, but are using fewer and fewer parts and accessories that differ from ours. In some cases, the special things they use are shipped over here for installation at the factory, and in other cases the items are shipped to England. The British are using Pratt & Whitney engines in some of their British-made planes.

PRESIDENT VISITS AIRCRAFT FACTORY

President Roosevelt, during his recent tour of the country, visited a Douglas Aircraft Company plant where he saw both bombers and cargo planes roll off the assembly lines. He is shown here in earnest discussion with Donald W. Douglas, Culbert L. Olson, governor of California, and Frederick W. Conant, Douglas vice-president in charge of manufacturing.

Martin Builds Cargo Plane

A cargo version of the PBM-3 *Mariner* twin-engine patrol bomber has been in production for some time for the Navy, Glenn L. Martin has revealed. The plane is "serving a very definite need for the Navy for transportation of critical supplies," he said.

At about the same time it was stated officially by the Navy that only one of the Martin *Mars* type flying boats had been ordered thus far, and that this one is being finished for cargo transport purposes. The Navy pointed out that large-scale production of this type craft would require enormous facilities and supplies of materials. One purpose in building the plane, Navy officials said, was to find out what happened when all dimensions of any airplane designed were expanded.

Russian Designer Dies

Sergei Chaplygin, Russian aerodynamics authority and head of the laboratories of the Aero-Hydrodynamics Institute of Moscow, died last month at the age of 74. Chaplygin's early research work led to establishment of basic principles on aircraft wing streamlining. He was a member of the Russian Academy of Science and had been cited as a Hero of Socialist Labor.

VERSATILITY PLUS

Late reports from the Southwest Pacific are that Martin B-26 "Marauders" are adding to their already impressive record for versatility. In addition to their normal function as medium bombers, the planes have served as land-based torpedo carriers. Now, it appears from reports from Gen. MacArthur's headquarters, the B-26's are feared as much as some fighters because the Zeros, "although they can outrun the heavier Martin, they can't outgun it; and at lower altitudes they can't even outrun it."

Higgins Wants to Build Big Cargo Airplanes

Andrew Jackson Higgins, New Orleans shipbuilder, has returned to Washington, endeavoring to interest the War and Navy Departments and WPB in authorizing him to build a pilot model of a very large cargo airplane.

It was understood that he saw high military and war production officials, and that they told him there were no more critical materials to spare for airplane projects. But Mr. Higgins, like Henry J. Kaiser, said that he would find all the necessary materials.

Higgins, unlike Kaiser, was not asking for an order. He said he was willing to go ahead and build his plane on his own. But presumably he would not be able to hire men and use any materials without authorization.

General opinion is that so long as existing airplane plants are short of materials and operating below capacity, no more construction facilities will be added.

WAR WORKERS PRESENT "THUNDERBOLT" TO AAF

Employees of the Bullard Company present a Republic P-47 "Thunderbolt" fighter to the Army Air Forces, becoming the first group outside the aviation industry itself to make such a donation. Inspiration for the purchase came when P-47's flew over the plant during awarding ceremonies in which company received the joint Army-Navy production award, and fund raising by and among employees was completed in two days. Above, Mrs. Esther Norrell (second from right) and Mrs. Elsie McKee, both Bullard workers and co-sponsors of the ship, with Mrs. Norrell's twin sons.

Navy to Get 14,611 More Planes; Plans Call for 31,960 in 1944

Washington (AVIATION Bureau)—The Navy is getting 14,611 additional airplanes at a cost of $2,862,000,000, included in the second war supplemental appropriation of fiscal 1943. About 68 percent of the total fund of $6,236,956,621 is for naval aviation: non-rigid airships, accessories; maintenance and operation; transport service; and miscellaneous.

This great expansion of naval air power is regarded as recognition of the part aviation has played in the Pacific war, and it may presage even further increases. The appropriation brings to $5,766,406,962 the total fund for naval airplanes since 1940, and it brings to about $12,000,000,000 the over-all total for naval aviation.

Navy's present airplane program objective is 27,500 by early 1944, and the rate of ordering has been more than meeting this objective. The present expansion provides for these same needs but on a larger scale, and it aims at an unstated numerical objective in planes by the first part of 1944.

But the need for planes is not Navy's only concern. Primarily, witnesses told House Appropriations Committee, the Navy wants to insure utilization of the full capacity of aircraft plants that are working on its orders. Comdr. G. W. Anderson told the committee that production gaps will appear in early 1943, and it is necessary to place orders to smooth out production.

The committee reports that there is no intention on Navy's part to go beyond its share of the President's program of 185,000 planes in 1942-43.

Of the total 185,000 planes, 15,000 in 1942 and 25,000 in 1943, are training planes, and they are not divided between Army and Navy, because some types are used by both. But most tactical planes are definitely assigned to either Army or Navy. Of tactical planes, the Navy gets 10,170 in 1942, and 21,790 in 1943. This makes total of 31,960 tactical planes, not including trainers and transports.

This program is not for our Navy alone; it includes planes we are sending and will send to the air arms of Allied navies. In addition, Navy gets nearly all of its transport planes from production in cognizance of the Army. Navy gets some of its tactical types from Army production too—types that are used by both services. Cognizance means that the plant is assigned to the Army, for instance, and that Army is boss of production, although not necessarily paying for all of it.

Long-range planning is necessary, Navy says, because airplanes must be put in process many months in advance. The engine is installed two months before the plane is delivered. Engines are usually under construction four months and in transit two weeks. Materials and components for the engines are in process for about nine months.

The bulk of the 14,611 planes in the expansion program are combat types, but the total does include 2,025 training planes to replace many now well worn at the training centers.

Navy says that its portion of airplane production is going up very rapidly and that it will near the peak toward the end of 1943, when the rate of output will level off quickly. The number of combat planes is increasing, while the proportion of training planes is decreasing.

There is reason to assume, though no official statements have been made, that the total Army - Navy - lend - lease airplane program will reach its peak about the end of 1943. Of course a new objective might be set before then, depending on how much of the war is fought in the air.

Adm. John Towers, former Chief of the Bureau of Aeronautics, now Commander Air Forces, Pacific Fleet, explained

FROM NEW B-17 PRODUCTION LINE

First Boeing B-17 "Flying Fortress" to come off the production lines at Vega Aircraft Corporation takes to the air months ahead of schedule. Vega is building B-17's under pooled facilities agreement in which it joined Douglas and Boeing to boost output of the big bombers.

to Congress that the number of planes on hand or on order now, to meet the objective of 27,500 early in 1944, would have to be far greater than 27,500. This is due to training and combat crackups, obsolescence and wearout. The excess of plane deliveries over the total force to be attained is called "slippage."

Adm. Towers said that the Navy's placing of orders to fill in production gaps will not result in more airplanes on hand than are needed. So long as the need for aircraft is unpredictable, Navy cannot get too many.

In addition to the $2,862,000,000 for airplanes, Navy gets $36,330,000 for blimps; $352,567,000 for stocks of accessories; $225,203,833 for maintenance and operation; $25,883,700 for transport service; and $320,015,467 for other purposes.

Anti-air Officers Needed

The Army needs officers for its anti-aircraft gun emplacements, and has called for volunteers from the 3-A ranks of the Selective Service to take training leading to commissions. A monthly quota of 500 Volunteer Officer Candidates per month has been established at the Anti-aircraft School. Qualified volunteers take a basic training course, which is followed by twelve weeks of instruction as officer candidates.

Marines Getting Gliders

Navy has placed orders for several hundred gliders for use by the Marines. Officials told an appropriation committee of Congress that the need for gliders had only recently been recognized. One school has been established in the East, and two more are in process of building, one other in the East and one in the Southwest. It was indicated that the seeming high cost of Navy gliders—$20,000 each—is due partly to the use of many instruments. Navy is buying two principal types: 12 place and 24 place. Training gliders are small of course; some have been obtained by leaving the engines out of small airplanes. Apparently the Marines do all the gliding, and Navy does not use this tactic at all.

Modification Centers Speed Plane Delivery

A dozen or more "airplane modification centers" have been established throughout the country. They are stations equipped and staffed to add special equipment or otherwise make warplanes ready for operations.

Working at top speed in day and night shifts, corps of factory - trained mechanics and technicians go to work on the planes as soon as they roll in from the factory, the Aero Chamber of Commerce announced.

Changes and improvements thus can be made without interrupting the flow of planes from the plant production lines so that a manufacturer is enabled to continue turning out the particular plane model while the plant is at the same time being tooled up to take care of whatever changes may be called for by an Army or Navy directive.

Modification centers came into being immediately after Pearl Harbor as the result of the desire of the Army Air Forces and the aircraft manufacturers to make such modifications in planes as might be dictated by experience gleaned from the fighting fronts.

These centers are being operated by nearly all of the principal aircraft producers, the list including Douglas, North American, Glenn L. Martin, Consolidated, Lockheed, Curtiss-Wright, Boeing, Vultee, and others. Flying away with the modified ship may be a special crew of technicians to set up a mechanics' station in some foreign land.

Dolan Buys Rearwin

Rearwin Aircraft Corporation has been sold to interests headed by C. H. Dolan, head of the Empire Ordnance Company, according to an announcement by R. W. Rearwin, president, who said he and his sons Kenneth and Royce would remain with the company as employees.

Pensacola Widens Program

Bronson Field, the fourth auxiliary base to go into operation under the Pensacola Naval Air Station's program of aviation training, was recently opened, affording one of the largest circle mats of any auxiliary base under this station.

Upon completion of their course at Pensacola, naval aviators will be better suited for night flying through experience gained under a recently inaugurated program. More interest has been shown by instructors and students in flying in darkness over the Gulf, and a course to prepare officers, cadets, enlisted men and British flight students to meet any emergency in the water is in operation. Divided into two sections, the pilots learn how to use a life jacket, assemble, inflate and handle rubber boats, and how to master a parachute in the water. The course includes rescue and artificial respiration of shipmates.

A detachment of Fighting French naval aviators will complete their training at naval aviation schools and bases in the United States and will later constitute a French unit to be furnished planes by this country, a recent joint announcement released in London and Washington stated. After completing their advanced instruction, the Fighting French pilots will operate in cooperation with United Nations Naval Air Forces.

International News Photo

HEADED FOR THE FRONT

Lockheed test pilot prepares to take brand new P-38 "Lightning" fighter aloft for final check before it goes to the Army Air Forces. Planes of this type have been commended by AAF officers for their work in the Pacific theater of war where American pilots are piling up an enviable record against the Japs.

MAJOR T. LEE, JR.

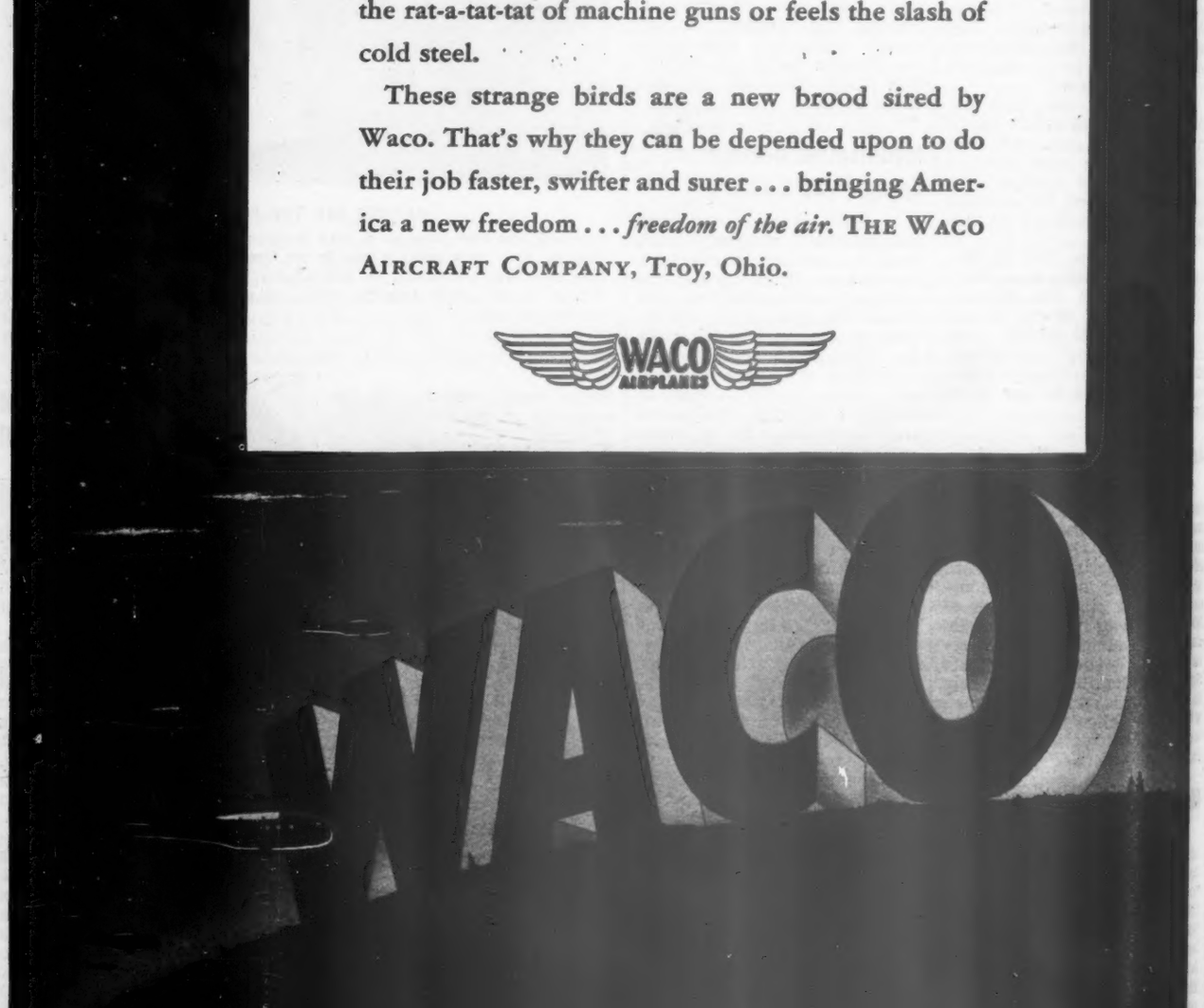
Former director of United Air Line's Boeing School of Aeronautics, T. Lee, Jr., has been granted leave of absence to become a major in the AAF Technical Training Command, UAL President W. A. Patterson has announced. Lee had been training large numbers of AAF technicians at Boeing School.

STRANGE BIRDS ON THE HORIZON

Seemingly they come out of nowhere . . . you hear no humming motors . . . yet these huge birds soar, dive and float to a graceful landing; disgorge 15 fully equipped fighting men itching for a scrap or ready to defend a strategic point. From whence they come, nobody knows. The enemy is not aware of their approach. He only knows they are there when he hears the rat-a-tat-tat of machine guns or feels the slash of cold steel.

These strange birds are a new brood sired by Waco. That's why they can be depended upon to do their job faster, swifter and surer . . . bringing America a new freedom . . . *freedom of the air.* THE WACO AIRCRAFT COMPANY, Troy, Ohio.

WACO AIRPLANES



Regulations Streamlined To Speed Civilian Flying

Civil Air Regulations are being streamlined to speed war and postwar civilian flying in a move expected to save hours of time formerly spent doing business with Civil Aeronautics Administration inspectors. CAA had begun work on a series of proposals for simplification before Pearl Harbor, and a number of these have been adopted by CAB. One outstanding recent change is the establishment of permanent airmen certificates, eliminating the requirement of periodic endorsement by CAA inspectors.

Periodic endorsement of aircraft airworthiness certificates has also been suspended for the duration. CAA had been conducting over 38,000 inspections of aircraft annually, each taking about 2 hr. In June, 1941, regulations were amended to permit approved repair stations to clear aircraft for flight after major repairs.

A comprehensive shakedown of regulations must wait until the pressure of war tasks is lifted, says CAA, but the men who write and the men who enforce the rules are agreed that when civil flying comes back into its own, it must not be hampered by an overwhelming mass of regulatory verbiage.

CAB Accident Survey

During the calendar year 1941, 4,252 accidents occurring in non-air carrier flying were reported to the Civil Aeronautics Board's Safety Bureau, an increase of 781 over the accidents reported for the previous year. However, during 1941, the average number of certificated pilots and student pilots increased to 175,828 as compared with 107,952 for 1940. Based on this average number of pilots and student pilots, there was a reduction of approximately 25 per cent in the accident ratio in 1941 as compared to 1940. In spite of this considerable increase in flying during 1941, there were 65 fewer fatal and serious accidents, a reduction of 15 per cent in number and a reduction in the accident ratio of 50 per cent.

Official USAAF photograph

PROMOTED

Col. Caleb V. Haynes, chief of the China Bomber Command, has been promoted to temporary rank of Brigadier General. Last spring he was assigned to head the Air Forces Ferrying Command in the India-Burma-China area, later taking over the Bomber Command. Gen. Haynes is a World War I flyer, having served as a test pilot and instructor in France.

110,000-Course Program Puts CPT on War Basis

Orders for tens of thousands of civilian pilot training courses have been received by the Civil Aeronautics Administration from the Army and Navy Departments within the last few months, bringing the total number of courses contracted for to over 110,000. These orders result in almost complete utilization of existing CPT facilities.

The new quotas fill the capacity of the advanced training courses and come near to filling the immediate capacity of the elementary courses. Operators have enough elementary aircraft to take on another 20,000 elementary courses, but this cannot be done until the necessary instructors can be trained. The elementary course, covers only a preliminary part of a pilot's training. Many Army and Navy trainees take as many as four or five CPT courses before going to active duty. All persons now being trained by the CAA are either Army or Navy enlisted reservists, which puts the training program on a complete war footing.

32-Year-Old Plane

A 32-year-old airplane with retractable tricycle landing gear, laminated wood stressed skin construction, and wings tapered in the modern manner, has just been dismembered and removed from a storeroom in Buffalo, where it has been since 1912. The plane was built there, during 1910-11-12, by Dr. Charles M. Olmsted, an aerodynamic engineer and physicist, formerly astro-physicist for the Mount Wilson Observatory, California.

A 70-mph. speed was expected from the Gnome 50-hp. motor. Because of financial difficulties the ship was not completed, but crude wind tunnel tests indicated it would have exceeded performance of any aircraft flying that time.

THE WASHINGTON WINDSOCK

By BLAINE STUBBLEFIELD

"Battleships now building are ahead of schedule by a total of 41 months," says House Naval Committee Chairman Vinson. This clears up the doubt of recent weeks whether work on them had been stopped, as many strategists believe it should be.

Which will win out? The fast, maneuverable, high-flying bomber armed to fight its way alone, or a new long-range fighter that can go with it. Air engineers are trying with all their might, the world around, to perfect both.

Last winter, as long nights came, Britain failed to attack Europe from aloft as effectively as promised. Only explanation was weather. De-icers, instrument approaches at home bases, hard runways and other aids have been in preparation all summer for the winterblitz.

The boom is here. We weren't sure till the other day when we met a lady who had quit her job with an aviation concern while her boss was away. She moved to another town and it took her three months to get her salary stopped.

It is sad to report that the war is still a fish fry in Washington. A few men struggle for production and war spirit, while the throng raids the stores and quits work by the 4:30 gong. And Washington is the scene of greedy grabs for high parties, high wages, and fat rations for the whole country. So far it's a sissybritches war in the nation's capital but, fortunately, some people are getting a little ashamed of it.

Senator George demands to know why CAA didn't promote air transport to a point where it could now provide large numbers of cargo planes. CAA replies it wasn't authorized by law to go beyond economic requirements. It should be recalled, however, that airline equipment, came to Army's rescue a year ago, and civil air transport personnel and skill are now the core of both Army and Navy transport services.

Navy's Air Transport Service had been operating several months before anything was said about it. Navy is using the JR2S-1, a version of the Vought-Sikorsky S-44, and the PB2Y-3, Consolidated flying boat. Eventually the Navy will have about nine types of air transport planes.

An important bomber, a bigger, faster, longer-ranged, higher-flying, better-armored and better-gunned version of one already on all warfronts, is going into service without a single brass band, without a single speech, and it is hoped, without one headline. Hitler and Hirohito will both know about it, may even have part of one in their possession, before the public is told anything at all about it.

A little wedge of time is given over by many major airplane companies to drawing-board speculation on what they will make after the war. No one knows yet whether our airplane capacity will be kept standing, or in semi-military readiness while producing civil goods, or shut down and perhaps dismantled, or converted completely to civil manufacturing. The airplane industry, with its knowledge of precision machine work, its skill in lightweight stress structure, sheet metal, wood, plastic and so on, is most versatile of all industries. It doesn't have to make airplanes at all. A list of products it has in mind would surprise you—and especially many an old line maker of standard wares.

Albert C. Read | Elliott Buckmaster | Charles P. Mason | DeWitt C. Ramsey | Arthur C. Davis | Frank D. Wagner | A. E. Montgomery

NAVAL FLYING OFFICERS PROMOTED TO RANK OF REAR ADMIRAL

Increased participation in the Navy High Command has been given aviation by promotion from Captain to Rear Admiral of seven flying Captains. In making the nominations, President Roosevelt jumped the men to flag rank over many surface Captains who had seniority over them, some with four years or more. Heading the list was Albert C. Read, pioneer Navy pilot who was in command of the NC-4, first plane to cross the Atlantic in August, 1919. Also on the list is Elliott Buckmaster, who was in command of the carrier Yorktown through the Battle of Midway. Charles P. Mason, a pilot with more than 25 years experience, was also promoted.

(Official U. S. Navy photographs)

CALLING NAMES

Novita (Novy) Holmes has joined Simmonds Aerocessories and will aid in getting out their house organ *Aeronews*.

Shirley Willoughby, gas and electric welder, and **Herbert Lebert,** both of UAL's production department, are the joint winners of the James F. Lincoln Arc Welding Foundation $2,500 Award for their work on a development project.

A. W. Herrington, Marmon-Herrington board chairman, has been elected a director of Aviation Corp.

F. M. Hoefler is named new president of Harvill Aircraft Die Casting and **Warren Stratton** has been elected to its board of directors. **H. A. Jones** has been named plant superintendent.

Louis A. Brown, Jr., formerly chief of the Subcontracting Section of WPB, has been elected first vice-president of Lights, Inc. **Thomas F. Morrissey** is recently appointed director of planning and engineering and **Victor G. Paradise,** director of sales. UAL announces the appointments of Miss **Iris Beals** as acting district traffic mgr. at Boston; **Walter Wehner** at Oakland and **James L. Snell** has been placed in charge of the Tacoma traffic office.

Antoine Hauet has been re-elected president of the Foremen's Club of Brewster Aeronautical. He is foreman of their Cowling Dept.

F. W. Ford has been appointed asst. to the vice-president of manufacturing for Ryan Aeronautical and **O. F. Rigley** will succeed him as purchasing agent.

H. Frederick Bright was appointed editor of *National Aeronautics*, NAA official magazine, and director of publicity, succeeding **John B. Goodman** who has been called to active duty as a lieutenant (j.g.) in the United States Naval Reserve.

R. E. Johnson was appointed mgr. of the Aviation Division of General Electric's Pacific District Industrial Department.

Robert P. Newton, former asst. chief of WPB's Bureau of Priorities, was elected senior vice-president of Aeronautical Chamber of Commerce.

Bendix Aviation announces a functional re-alignment of the executive staff: **Charles Marcus** becomes VP in charge of engineering throughout the corporation; **D. O. Thomas** VP of manufacturing; succeeded by **Malcolm P. Ferguson** as VP and group executive of the Western Group; **Marvin A. Heidt** staff asst. in charge of Industrial Relations; **Raymond P. Lansing** VP and group executive in charge of Eastern Divisions; **G. R. Schenck** his staff asst. in charge of industrial relations for the Eastern Group; **Arthur E. Raabe,** asst. gen. mgr. of Eclipse-Pioneer; **Kenneth MacGrath** asst. gen. mgr.; **William L. McGrath** is re-appointed VP of Bendix Aviation and gen. mgr. of Eclipse Machine; **T. W. Tinkham** gen. mgr. of the Products Division; at Bendix Radio Division; **Hugh Benet** becomes gen. mgr.; **N. B. McLean** gen. mgr. and in the Marine Division **G. W. Smith, Jr.,** is named gen. mgr.

Donald G. Ogden and **Richard A. Fagin** have been named asst. chief pilots for American Airlines.

Robert S. Swain was elected vice-president and treasurer and a director of Northeast Airlines.

Alice Severance, senior stewardess of UAL, leaves the airway to become a technical assistant in UAL's medical center.

Whitney C. Collins was elected vice-president in charge of sales for Elastic Stop Nut, of which he has been a director for the past two years.

Robert P. Breese, formerly of Bendix has joined General Bronze Corp. as industrial development engineer.

B. J. Vierling was appointed supt of maintenance of Penn-Central.

Charles H. Gale has joined the public relations staff of the Fairchild Engine & Airplane Corp.

Gertrude Hill Fila has transferred from Lockheed (where she was the first woman tool designer) to Vega Aircraft as an engineer assigned to the Natl. Aircraft Standards Committee.

Robert Miller was elected vice-president and secretary and **Edwin V. Carlson** treasurer of Menasco Mfg.

J. P. Joyner and **Vincent Stott** have been appointed to newly created posts of Eastern and Atlantic division stations supervisors of TWA; **A. W. French,** mail and express traffic manager; **Paul P. Smith,** station manager at LaGuardia Field and **H. G. Andrews** will now headquarter at Albuquerque.

Harold P. Wade transfers as mgr. of Adel Precision California branch and **Jack Horning** has been appointed to the engineering service staff.

Paul G. Sturges has been appointed director of public relations and advertising for Southwest Airways.

Richard N. Kraschel and **Robert F. Morris** have joined Bell to do production test flying.

Branch T. Dykes was elected vice-president in charge of maintenance of Colonial Airlines; **Francis J. Hartley** to the board of directors and **Carl L. Anthony** asst. secy.

Richard C. Long has been appointed regional director, Atlantic Division of Pan American, and **John C. Leslie,** manager of the Atlantic Division has accepted an appointment as a member of the Committee on Operating Problems of NACO.

Thomas A. Morgan, president of Sperry, reports that the aviation industry in New York City has contributed over $42,000 to the Greater N. Y. Fund.

Maj. Gen. George C. Kenney succeeds Lt. Gen. George H. Brett, who is home in this country on leave.

George P. Baker has resigned as a member and vice-chairman of the CAB to give full time to his duties as chief of the Requirements Division of the Office of Quartermaster General, War Department, to which he was temporarily assigned last spring.

Tom O. Duggan has been elected a vice-president of Thompson Products.

Lillian Brown and **Marion Lavine,** TWA reservations representatives, have been promoted to traffic representatives, up till now a strictly masculine field.

Charles Morris has joined the staff of Airesearch as installation engineer of the High Altitude Cabin Equipment Division.

Croll Hunter, president of Northwest for the past five years, was re-elected chief executive of the NWA system: **Linus C. Glotzbach** has been named as his assistant in charge of personnel administration: **Capt. Hal B. Freeburg,** veteran pilot, has been named check pilot for the system; **Don J. King,** member of NWA pilot corps for six years, has been named sup't of the Eastern division.

E. I. Whyatt, secy. and treas. of Northwest Airlines for eight years, has been made vice-pres. and **A. E. Floan,** director of their bureau of economic research, has been elected secy. of the company.

Paul G. Sturges has been appointed director of public relations and advertising for Southwest Airways.

Andrew H. Phelps has been elected vice-president of Westinghouse Electric. He joined Westinghouse in 1937, after having served as sales manager and public relations director for McGraw-Hill for seven years.

William A. Lippman is made head of the express and freight department at Western Air.

Capt. George Rice, veteran TWA pilot, has been promoted to system chief pilot, succeeding **Capt. W. G. Gollen** who has been assigned to special duties.

Bell Aircraft's magazine, the BELLRINGER, has a new secret weapon: they spell hitler and japanese with small initial letters, thereby shrinking them down to their actual size.

Harry M. Arnold is appointed asst. service mgr. of Hamilton Standard Propellers.

John J. Hospers is appointed sales and service mgr. of Vought-Sikowsky.

Capt. Murl Estes is the 128th PCA employee to join the armed forces.

H. O. Sawyer, leadman at Consolidated, has turned in 16 short-cut suggestions, 11 of which have been approved and put into use.

Eugene E. Wilson, United Aircraft president, is awarded the honorary degree of Doctor of Science for his services to the aircraft industry.

Earl F. Findley, publisher, UNITED STATES AIR SERVICES MAGAZINE, receives the honorary degree of Doctor of Letters, conferred by Parsons College, Iowa, for his contribution to aviation news.

Frank A. Sharpe has been promoted to sales mgr. of Mid-West Abrasive.

Col. Elbridge G. Chapman, Jr., Infantry, has been assigned command of the Airborne Command, headquarters of which are at Ft. Bragg, N. C.

NO INTERNAL DI

Clutch and Valve "Harmony" Is Machined from OHIO SEAMLESS TUBING

● Even in quiet flight formation every part of the operating mechanism must do its intended duty surely and continuously. At some of the most vital spots in many types of fighting aircraft, this wear-and-tear responsibility is shouldered by a partnership between OSTUCO Tubing and accurate machining and finishing.

Two such vital parts are valve rocker shaft bushings and high ratio clutch gear bearings. Beyond meeting strict Army and Navy specifications, special care is taken in drawing and treating the tubing to provide properties which help in later operations. For this reason Ohio Seamless Tubing has earned a remarkably consistent record of low rejection percentages over a long period of years.

New steels, new specifications, a wide variety of gauges, lengths and finishes provide a wealth of new experience that is invaluable in solving the problems of present and prospective customers.

MACHINED AIRCRAFT PARTS FINISHED FROM OHIO SEAMLESS TUBING. (PHOTO COURTESY OF CLEVELAND GRAPHITE BRONZE CO.)

THE OHIO SEAMLESS TUBE COMPANY

SHELBY OSTUCO OHIO

PHOTO COURTESY OF U. S. ARMY AIR CORPS

WORK IT HARD, BUT GUARD IT WELL

OF COURSE, you are driving your Aluminum Alloy equipment to the limit. We need every gallon, every pound, every foot, every piece of the products that can possibly be produced to help win the war. But, bear in mind that you must make your equipment last a long time.

YOU CAN lengthen the life of hard-working, irreplaceable Aluminum Alloy equipment. Here are some ways of doing it; each must be engineered to suit the problem.

CATHODIC PROTECTION has proved effective where the chemicals or cooling water employed are corrosive. Simply add zinc strips in the right places, and the corrosive attack is stopped or slowed down considerably. Alcoa engineers, with years of research on such problems, can advise you on how and where to place those zincs.

PROTECTIVE COATINGS offer another means of making Aluminum Alloy parts last longer. Corrosion-resisting, pure Aluminum coatings can be applied by spraying. Oxide finishes are produced by chemical and electrolytic treatment. Baked resin coatings are very effective, where Aluminum is subjected to severe attack.

METALLIZING—building up worn, corroded, or damaged Aluminum parts with new metal—will give these parts a new lease on life.

INHIBITORS may be the key to longer life of Aluminum Alloy processing equipment. Only a few parts of inhibitor per million of liquid are needed to deprive corrosive materials of their kick. Here again, the research of Alcoa engineers will guide you.

ALCOA ENGINEERS stand ready to help you get every possible hour of service out of your Aluminum Alloy equipment. Write and tell us your problems. Aluminum Company of America, 2182 Gulf Building, Pittsburgh, Pennsylvania.

ALCOA ALUMINUM

Eight Eastern Aircraft Manufacturers Establish War Production Council

To speed war plane production, East Coast manufacturers have formed a non-profit corporation known as Aircraft War Production Council, Inc., East Coast. Patterned after a successful Pacific Coast organization the council plans to pool research, engineering, manufacturing technique, materials and personnel. It will cooperate closely with the West Coast Air Production Council, the Automotive Council for War Production and with government agencies.

At present the council consists of eight air frame manufacturers, whose policy will be governed by a board of directors made up of the heads of the member companies. The group includes Guy Vaughan, president of the council and head of Curtiss-Wright; Glenn L. Martin, first vice president of the council and president of Glenn L. Martin Co.; Victor Emanuel, Aviation Corporation; L. D. Bell, Bell Aircraft Corporation; C. A. Van Dusen, Brewster Aeronautical Corporation; L. C. Goad, Eastern Aircraft Division of General Motors Corporation; J. Carlton Ward, Jr., Fairchild Airplant & Engine Corporation; and Ralph S. Damon, Republic Aviation Corporation.

Absent from the Eastern council are United Aircraft and Grumman. Vaughan expressed his belief that United will join later and said he was assured of full cooperation from Grumman.

The presence of General Motors in the group marks the first non-"old line" aircraft company to be admitted to the fold. It is understood that later the council may include manufacturers of engines and accessories.

The California organization which has been operating successfully for the past six months includes Consolidated, Douglas, Lockheed, Northrop, North American, Ryan, Vega, and Vultee. Donald Douglas, its president, reports that members have made 4,151 exchanges of materials; engineering reports on more than 1,000 subjects were swapped; also traded were listings of production machinery.

Ryan Builds Combat Planes For Navy

Combat planes for the United States Navy are now being built by Ryan Aeronautical Co., according to T. Claude Ryan, president of the firm, which in the past manufactured only training planes, exhaust manifolds and other parts. Contracts have been signed for volume production of SOR-1 scout observation planes, a ship or land-based aircraft designed for long-range naval scouting missions. The basic type is a Curtiss-Wright Corp. design for the Navy. As being made by Ryan, the SOR-1 is a mid-wing monoplane, powered with a Ranger inverted V type in-line 12-cylinder, aircooled engine, an all-metal construction of sem-monocoque design with a two-place tandem cockpit arrangement. Wings and tail unit are of cantilever design.

Metal Ration Plan Formed

To further conserve and utilize with utmost efficiency, WPB is now putting manufacturers on a materials ration. The exact amounts of steel, copper, magnesium, aluminum and the alloying metals we had in stockpile and otherwise available was never determined and the various war control, agencies —Defense Commission, OPM, SPAB, and later WPB—authorized more priorities than supplies justified.

The Production Requirements Plan tightened the controls but apparently not enough. Eventually will come something called a "warrant" plan, by means of which the prime contractor will be told to make a certain amount of certain products. These certain amounts will be based on the amounts of metals and other materials in WPB's inventory, which is now approximately correct.

In other words, instead of making application for preferences, or applying for allotments under PRP, the manufacturer will be relieved of standing in line for materials. Of course preference ratings and PRP will remain in use for some months yet.

Appointment of Charles Wilson, of General Electric, and Ferdinand Eberstadt, of the Army-Navy Munitions Board, as vice chairmen of WPB is a part of Nelson's plan to coordinate the flow of materials with production schedules. Wilson will see that production schedules are met, and Eberstadt will regulate the flow of materials.

NACA Shifts to Projects Of Immediate Importance

The National Advisory Committee for Aeronautics has changed its program to cover more projects of immediate importance in the war, and fewer of the long-range, or "pure science" projects. This policy applies to all of its major divisions. Some of the immediate problems in the NACA laboratories must be solved before production of aircraft and engine and plane accessories are started. This change is necessitated by rapid technological change in the whole realm of war aviation.

NACA officials do not name any of the projects, but reasonable assumption is that de-icing equipment, superchargers for air fighting and bombing at still higher elevations, various aids to pilots at high levels, radio direction, and many others are included.

Labor Allocation Predicted More Women for Factories

Washington (AVIATION Bureau)—Next in importance to materials comes manpower, and the long-anticipated shortage is now upon us.

Some sources insist that 13,000,000 men will be under arms by 1944. We have about 27,500,000 men between 18 and 45, of whom only about 13,500,000 are sound enough to pass the military examinations. That skims off the cream, and the balance, plus men over 45, composes our total male worker force.

Except for the women. The War Manpower Commission and WPB officials are telling industry it will have to get ready to use women and girls in more and more jobs. Even the aircraft industry, which is pointed to as a model of conversion from manpower to womanpower, will have to shift a still bigger slice of its jobs to feminine hands.

Washington is trying to formulate a law which it would hate to call forced labor, especially during an election year. But there will be some kind of statute empowering the Executive to tell workers to take certain jobs, or tell them to stay put. This is a delicate undertaking in a democratic country. Just how far the law may go, and how far the President might go in its enforcement, cannot be told in advance. Right now, the government wants all

INVADING MEN'S FIELD

Women take over drawing boards for drafting work on details of Rolls Royce aircraft engine being built by Packard. The ladies began by doing tracing and redrawings, progressing rapidly to status of skilled draftswomen. Packard believes this is the first time women have been employed by motor car plant for drafting.

essential employers to hire their men through the U. S. Employment Service, which is trying to allocate the workers, just as WPB is allocating the steel, copper, aluminum and other material supplies.

NAA Wind Tunnel

Capable of producing a 327 mile per hour airspeed, a new wind tunnel is nearing completion at the North American Aviation plant. Delays now caused by the overload condition of existing tunnels in southern California will be largely eliminated. Engineers have been compelled to wait weeks—and sometimes months—for their turn at the wind tunnel, NAA says. The tunnel narrows to a throat 7¾ ft. high and 11 ft. wide in which the testing is done. A seven-bladed, 19-foot propeller, turned by a 3,000 hp. electric motor provides the airstream. Propeller speed can be varied between 70 and 700 rpm.

4,151 Material Trades By Production Council

Exchanges of material among southern California member companies of the Aircraft War Production Council, Inc., totaled 4,151 in the six months since the council was founded, according to a report by Donald W. Douglas, president of the organization, for the past quarter. Engineering reports covering more than 1,000 subjects were also exchanged. Cargo plane deliveries by council members increased more than 1,100 percent and total plane deliveries of all types increased 113 percent since Pearl Harbor.

Harry Woodhead, president of Consolidated Aircraft Corp., was elected to succeed Mr. Douglas as president, and Robert E. Gross, president of Lockheed Aircraft Corp., was elected vice-president. Offices of the council are rotated quarterly among the chief executives of the member companies. Member companies are Douglas, Lockheed, Consolidated, Vultee Aircraft, Inc., Ryan Aeronautical Co., North American Aviation, Inc., Vega Aircraft Corporation, and the Northrop Aircraft Corporation.

MIGHT BE RUSSIA?

Wright Cyclone engine undergoes extensive test under conditions simulating sub-zero temperatures similar to those which United Nations face this winter in Alaska, Iceland, Labrador, Russia and other "ice-box" fronts. Test is one of a long series of experiments giving data on both engines and accessories.

Propose Rope Standards

A proposed simplified practice recommendation for wire rope has been submitted to producers, distributors and users by the Division of Simplified Practice, National Bureau of Standards.

Including sizes, constructions, grades and breaking strengths, the recommendation would reduce varieties from 973 to 643, or 33.9 percent.

Their major production and use is covered by four constructions, where reduction is from 352 to 182 items.

ASSEMBLY LINES . . . By Dorsey Adams

Explosive rivets seem to have quite a future. E. I. du Pont, which makes the stuff in the business end, reminds you that these rivets played an important part in speeding aircraft production, and tells you how they are now hurrying field repairs to damaged planes. Repairs that formerly required days are now completed in hours. These rivets, which have explosive matter in a cavity at the end of the shank, are installed by one man at a rate of 15 to 20 per minute, compared with two to four a minute for most "blind" fasteners. Their big advantage is that, even if you have two men for both sides of the work, sometimes there's no room for a man on the inside. The explosive rivets weigh only one-fourth as much as regular fasteners, says du Pont. Heat applied to the rivet head with an electric gun detonates the charge.

Wright Aeronautical Corp. announced that one of its aircraft engine manufacturing plants has developed a fast chip handling system which daily removes tons of steel, aluminum, magnesium, brass and bronze scrap without interfering with production. In less than 40 min., a miniature haystack of long, curly shavings can be removed from a machine in a special metal container, dumped into a conveyor train, crushed, freed of machine oil and compactly packed in a railway gondola a half mile from the factory. The system also segregates each metal at the source, thus avoiding complicated separation processes; it handles the chips with small loss, saves a large number of man-hours and conserves already overtaxed shipping space by reducing the voluminous shavings to compact form.

An engine change in 54½ min. is the unusual feat recently accomplished by hangar mechanics at Republic, an apt demonstration of the facility and interchangeability of the *Thunderbolt* design. The workmen, who had set a record of 1 hr. and 18 min., tried again in the afternoon of the same day and cut that time by 23½ min. Both times were substantially below the limit called for by wartime requirements. The 2,000-hp. Pratt & Whitney engine had been running and was hot when the change operations got under way. The demonstration was to prove the P-47 design, a regular procedure in the aircraft industry.

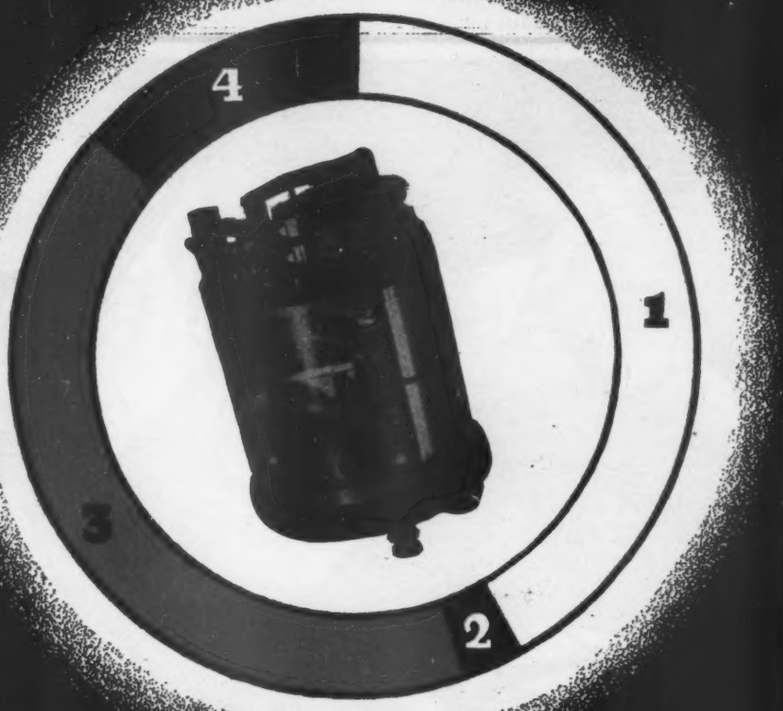
R. K. Dundas, Ltd., of Portsmouth, have produced the Vernijigger to meet the need for a cheap and convenient means for accurately drilling and marking out jigs and fixtures, or for making single components for an experimental article. The Vernijigger is a form of jig borer with an accuracy claimed to be equivalent to anything encountered in normal working, or a maximum permissible error of plus or minus .0005 in. It can be used with a radial drill, sensitive bench drill, hand pillar drill, moving head drill, hand pistol grip type drill, or an electrically or otherwise operated hand drill brace. It can be made in a range of sizes, but the standard instrument has 12-in. arms.

A 3,000-hp. fuel oil injection engine capable of powering the huge bombers of the immediate future is under development at Canadian Car & Foundry Co., Ltd. The company, through its own engineering division, also designed and completed an aircraft radial engine in the 180-hp. class for the lighter training planes of the British Commonwealth Air Training Plan.

Another major step in the expansion of business at Kellett, and the future deliveries of parts for fighter planes, was made when the first jigs for subcontract work were moved in and production got under way. The plant involved has been confined entirely to the autogiro program but space has always been reserved for the assembly of subcontracted surfaces. The production of these parts will be on an assembly line basis. At present there are four lines with the possibility of a fifth being added at a later date.

Approximately 250,000 women will be employed in the aircraft industry by the end of this year, compared with only 2,000 a year ago, the Women's Bureau of the Department of Labor estimated. Based on a nation-wide survey of the airplane industry, the report said the greatest opportunity for women workers is in subassembly plants where parts and sections are comparatively small. There the operations are broken down into repetitive work, which women learn easily and quickly and "stick to" longer than men.

for flashing tail lights that are ALWAYS accurately timed



1
WHITE—150 DEG.
(0.625 sec.)

2
DARK—10 DEG.
(0.042 sec.)

3
RED—150 DEG.
(0.625 sec.)

4
DARK—50 DEG.
(0.208 sec.)

C.A.A. requirements for flashing red and white tail lights specify 40 cycles per minute, divided as shown in this timing chart. To meet these requirements with sustained accuracy, all leading airlines are equipping their air-carrier aircraft with this *C.A.A. Approved* flasher mechanism.

Photograph showing actual installation courtesy of American Airlines, Inc.

THE split second timing of the W&T flasher mechanism is held constant by a governor which will compensate for as much as 20% variation in operating voltage. Lamp contacts will handle as many as three 32 candlepower lamps on each circuit. In the event the time cycle characteristic were to be changed in the future it would be merely necessary to replace the two program discs.

The W&T mechanism will function properly in any position when installed with longitudinal axis normally vertical. It causes no objectionable radio interference and is temperature compensated, thereby meeting all C.A.A. requirements including those for vibration. It is highly compact and simple to install. For complete information write for Technical Publication 234. A-2

WALLACE & TIERNAN PRODUCTS, INC.
BELLEVILLE, NEW JERSEY

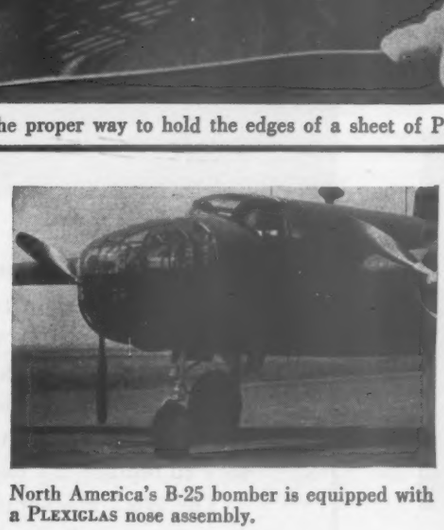
Forming Plexiglas

A Rohm & Haas worker demonstrates the proper way to hold the edges of a sheet of PLEXIGLAS against the cloth-covered form.

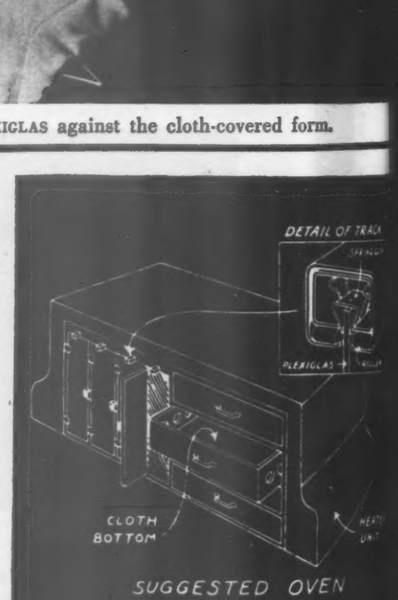
ROHM & HAAS recently published a booklet that belongs in the hands of every executive and engineer charged with the production of PLEXIGLAS naval, military and aircraft units.

Its name is the PLEXIGLAS *Fabricating Manual.* Its 48 pages contain every important fact on the fabrication and proper handling of crystal-clear PLEXIGLAS.

At this time, when our country needs every PLEXIGLAS unit that it is possible to produce, Rohm & Haas is glad to pass on the benefits of its experience with acrylic plastics. Copies of the new PLEXIGLAS *Fabricating Manual* will be furnished on request.



North America's B-25 bomber is equipped with a PLEXIGLAS nose assembly.



A diagram from the new PLEXIGLAS *Fabricating Manual,* showing an oven which has proved ideal for heating PLEXIGLAS for forming.

THE CRYSTAL-CLEAR ACRYLIC PLASTICS

PLEXIGLAS ★ **CRYSTALITE**

SHEETS AND RODS — MOLDING POWDER

PLEXIGLAS and CRYSTALITE are the trade-marks, Reg. U. S. Pat. Off., for the acrylic resin thermoplastics manufactured by the Rohm & Haas Company.

ROHM & HAAS COMPANY

WASHINGTON SQUARE, PHILADELPHIA, PA.

Manufacturers of Leather and Textile Specialties and Finishes, Enzymes, Crystal-Clear Acrylic Plastics, Synthetic Insecticides, Fungicides, and other Industrial Chemicals

CAB Asked for Caribbean Routes To Break Inter-American Bottleneck

The largest scramble for certificates of convenience and necessity is going on in Washington at the moment, where some 14 airlines are trying to get a part in the proposed services around the Caribbean. At the time of writing, five applications, involving Waterman Airline, Colonial Airlines, Transportes Aereos Colombianos, Aeroplanos de Carga Latino-Americanos and Transportes Aereos Venozelanos have been dismissed by the Civil Aeronautics Board for one reason or another. Furthermore, W. R. Grace, filing for Panagra to obtain a port of call in the United States, was also turned down for the time being. One other company, the Compania Nacional Cubana de Aviaciones, came in about a week after the official closing date, and was not allowed to participate in the coming battle.

As matters stand now, two American airlines, one English, one Dutch and three Central American companies will have a consolidated hearing on their proposed services, which from all indications will be designed to give the Caribbean area, until now served more or less exclusively by Panam as far as U. S. ports of call were concerned, a really adequate wartime transportation system.

In connection with this sudden about face of the CAB, which had long discouraged applications for expansion in the Caribbean, many an airline felt rather irked that it should come at a time when they had their hands full running cargo for the armed forces to all corners of the world. Add to this the fact that the airlines had been forced to turn over a goodly part of their fleet to the armed forces, most of them were caught rather short handed and short tempered at this sudden development.

Of all cases which have come before the board in the past years, this one may prove to be among the most interesting and probably the most controversial. Main question to be decided appears to be whether the airlines which get the much coveted permits will have the experience and equipment to operate adequate and safe services. A second question will be whether American air lines should be shown any preference over British and Dutch lines.

The two American companies, National Airlines and Eastern Air Lines, both appear to be in a good position as far as equipment and experience are concerned. Both lines are hoping that the constantly increasing cargo plane production will give them back some of their DC-3's, Eastern more so than National, since the latter has been using equipment which has not been so much in demand, but which still has been used in the general aircraft pool. Whether they get back equipment or new equipment, both lines at least have sufficient planes to supply good service.

The two lines run by Lowell Yerex, the TACA and British West Indian Airways, have been for some time categorically short of equipment, due to the job which TACA has been doing in freight flying for some time. TACA's equipment consists of some Lockheed 14's, a Lockheed 14-C, and some converted Junkers and Fords. According to the latest reports, BWIA has two *Lodestars*, which are pretty well occupied with services to British possessions from Trinidad and their single run to Miami, which they have maintained since getting CAB's temporary permit.

Little is known right now about the two other American airlines, Aerovias Nacionales Puerto Rico and Expreso Aereo Inter-Americano. The latter appears to be new in the field, while the Puerto Rican line has been operating for some time with small equipment and seems to have done a good job.

The Dutch KLM, operating in the Caribbean since 1935 with permanent hopes to get into Miami, lost its pioneering manager in 1941 due to KLM-KNILM politics, and has been short handed as far as equipment goes since 1940, when its two DC-5's were confiscated by the KNILM. Its fleet until recently consisted of four Lockheed 14's and an old Fokker tri-motor of 1931 vintage, but an unpublicized crash at the end of August caused the loss of one Lockheed, together with its crew of three and ten passengers in the Trinidad jungles. Backed by long experience and a first class record, and given adequate equipment and leadership, the KLM should finish among the leaders.

It will be clear from the above resume that the CAB will be forced to set a number of important precedents, which may be of vital influence for the shape of the post-war air transportation picture. For the time being, at least, the main requirement should be the best, safest and cheapest service that wartime can provide, which seems to point to certificates for the duration only.

CITY HONORS AIRLINES

J. W. Miller (left), president, Mid-Continent Airlines; Paul E. Richter (center), executive vice-president, Transcontinental & Western Air; and Charles E. Beard (right), vice-president, Braniff Airways, hold plaques presented by the aviation department of the Kansas City, Mo., Chamber of Commerce in recognition of excellent work done by the air transport industry in the war effort.

CAB Suspends UAFC Service

Civil Aeronautics Board ordered Universal Air Freight Corp. of Delaware to stop its air transportation without an operating certificate of public convenience and necessity. The board stated that within the meaning of the Civil Aeronautics Act, Universal was engaged in air transportation and was operating without the necessary certificate.

The Universal Corporation, a wholly owned subsidiary of U. S. Freight Corp., has been operating since July 10, 1941, in the business of forwarding air freight by collecting packages from original shippers and consolidating such individual packages into larger packages for shipments in bulk over domestic airlines.

In 1941, Universal sought a certificate to perform service involving direct transactions between it and the airlines, rather than by shipping through the American Railway Express Agency. Action on this application has been indefinitely suspended in order not to divert the time and energy of air carriers and government agencies from the tasks connected with the war program.

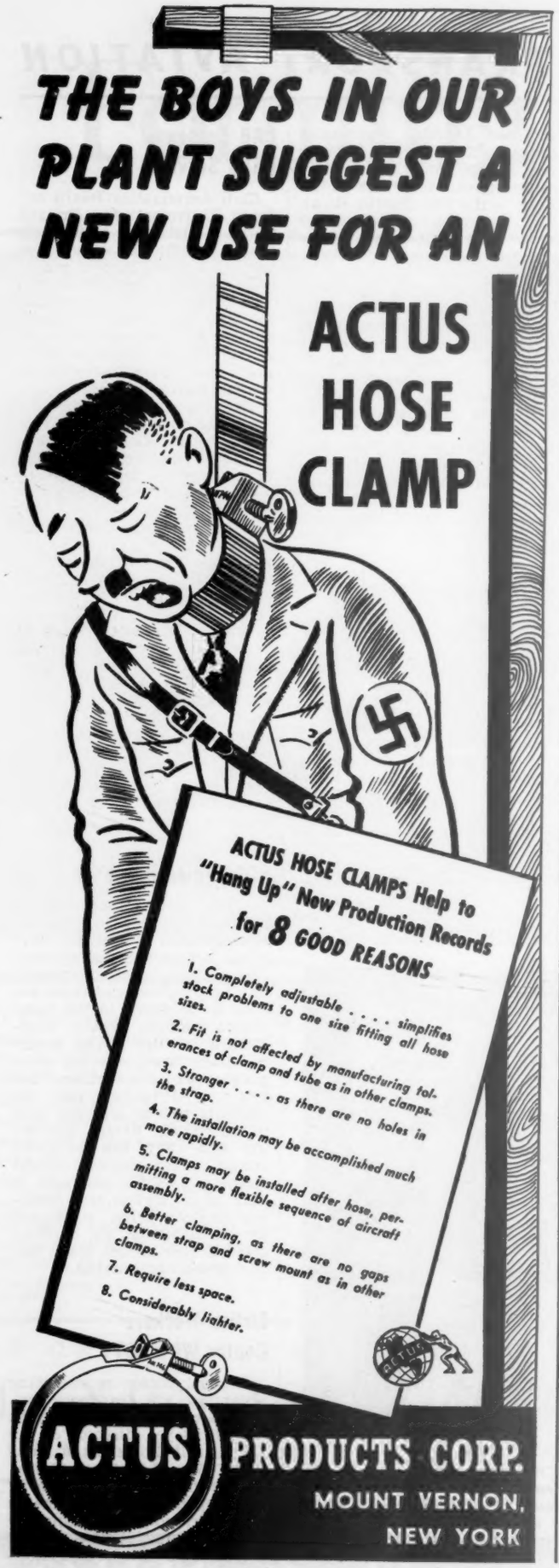
PCA Trains Pilots

A new airline pilot training program has been started by Pennsylvania Central Airlines. A fleet of Stinson monoplanes has been purchased for the program and these are soon to be flown to the company's training center. Candidates for the airline training have been selected from graduates of the Civilian Pilot Training Program and the students will be schooled first in instrument flying. Following this they will be given actual multi-engined flight training. PCA's program is part of an airline war training project being conducted by all domestic air carriers. Over 40 new airline pilots can be trained each month.

Airline Workers Confer With ODT

A committee representing organized air transport employees conferred recently with Otto S. Beyer, director of the Division of Transport Personnel, Office of Defense Transportation, on the problem of future personnel requirements in the rapidly expanding air transport industry.

Questions discussed includ-


THE BOYS IN OUR PLANT SUGGEST A NEW USE FOR AN
ACTUS HOSE CLAMP
ACTUS HOSE CLAMPS Help to "Hang Up" New Production Records for 8 GOOD REASONS
1. Completely adjustable . . . . simplifies stock problems to one size fitting all hose sizes.
2. Fit is not affected by manufacturing tolerances of clamp and tube as in other clamps.
3. Stronger . . . . as there are no holes in the strap.
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7. Require less space.
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ed the effect of selective service on ground crews, the need for a large-scale training program for new employees, the recruitment of new personnel, and methods for obtaining the most efficient utilization of available manpower. The conference approved the increased employment of women in the office and ground forces of the airlines, and favored the creation of a labor-management committee to facilitate the conservation of materials and equipment used in air transport.

Army Takes Over Work Of Pan American Air Ferries

Army crews took over the operations of Pan American Air Ferries Oct. 1 when the contract expired, the War Department announced. Ferrying lend-lease and other aircraft to American and Allied forces in the Middle East will be handled directly by the Air Transport Command under Maj. Gen. Harold L. George.

The official statement said that Air Forces considers it undesirable to have civilians flying the military planes, and that some of the pilots now on the service will be commissioned and will continue their jobs. One unofficial source said that the Army, in making the change, simply wants to cut expenses by the difference between civilian and military pilots pay.

It is understood that both military and civil airplanes are ferried overseas by other lines in addition to PAA, including United, TWA and Eastern, but the Army would make no comment concerning the status of these contracts.

10 Cargo Types Fly War Routes; Alaska-Russia-China Run Opened

Washington (AVIATION Bureau)—Now that a nearly complete set of facts and opinions has been pried loose from responsible sources, it appears that the cargo plane program pleases nearly everybody. First, the high command of United Nations does not want a supercollossal air fleet. Second, such a fleet could not be produced in time to affect the present phase of the war.

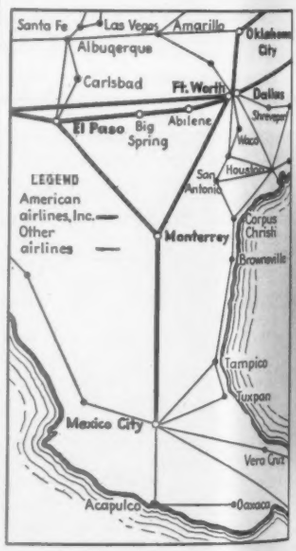
Air Forces Chief Gen. Henry H. Arnold says that in 1942 some 21 percent of all multi-engined planes produced will be cargo ships. During the first half of 1943, he says, this figure will increase to 30 percent, going higher during the last six months.

Although the experts are agreed that 40,000 planes of the B-19 type could carry the load of the entire United Nation's merchant fleet, they agree also that we cannot stop building merchant ships while we make a shift to air on a grand scale. The fueling of an air fleet of that size would require a large transport service itself, for it would use about 8,000,000 gals. per hr.

If the war command wanted the air fleet, it would take a long time to tool up and train the men to make it out of the proposed "non-strategic" materials—steel and wood. As a matter of fact, the steel is not available, and the plywood industry is already working at capacity.

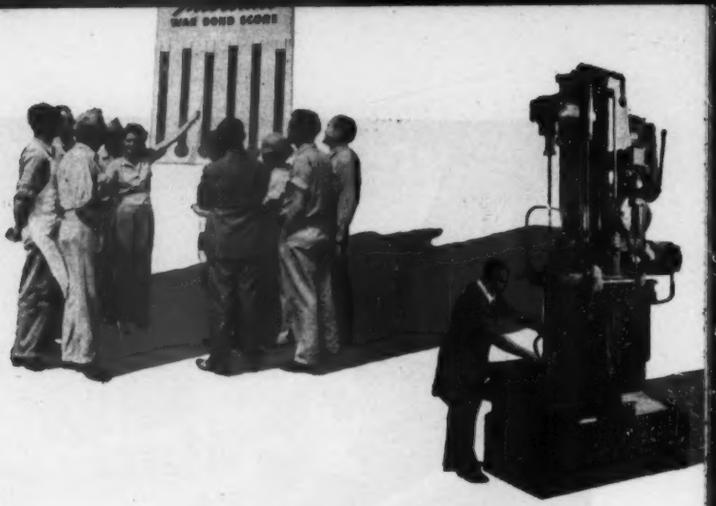
The Aeronautical Chamber of Commerce says that hundreds of cargo planes are already operating on four main routes: West Coast to Australia and New Zealand; Alaska to Russia and China; East Coast to Britain, via Iceland; and via South America to Africa and Egypt, thence to the South Pacific battlefronts and India. By the end of 1943, the statement says, Air Transport Command capacity will approach parity with wartime ocean shipping.

Meanwhile, the Navy is operating an Air Transport Service, probably over sea-routes only. This service will be greatly expanded.



GOOD NEIGHBOR ROUTE

The new route recently opened to Mexico City by American Airlines, Inc., gives direct connections from both east and west coasts of the United States to the republic south of the Rio Grande. Stewardess service is provided and international passengers are allowed 55 lb. of baggage free.



—where the spirit is "WE"

YOU SENSE IT the moment you enter an Interstate plant... a spirit easy to recognize yet hard to define. A spirit of teamwork, of shoulder-to-shoulder service in a great cause.

Here a complete complement of the finest precision machines operate 24 hours a day, 7 days a week. Here master craftsmen turn out vast quantities of vital aircraft units as finely measured as a Swiss watch. Here a large corps of trained inspectors with minute gauges and costly testing machines check every operation, every part, that go into these fighting units.

All play the game together. All have the same passion for precision; the same blending of accuracy and speed. All are moved by the same quick-step spirit; a spirit that makes every Interstate operation spell co-operation; a spirit of "WE."

Interstate

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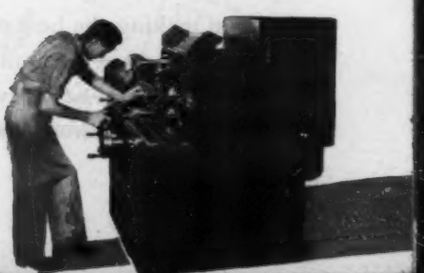


South Wind Heating
MEETS YOUR NEEDS

Both combustion and exhaust-gas systems—developed and proved under flight conditions—permit unbiased study of your problems

WIDELY varying installations demand widely varying equipment. And unbiased recommendations for your needs can best be made by someone who knows and supplies *all* types of equipment.

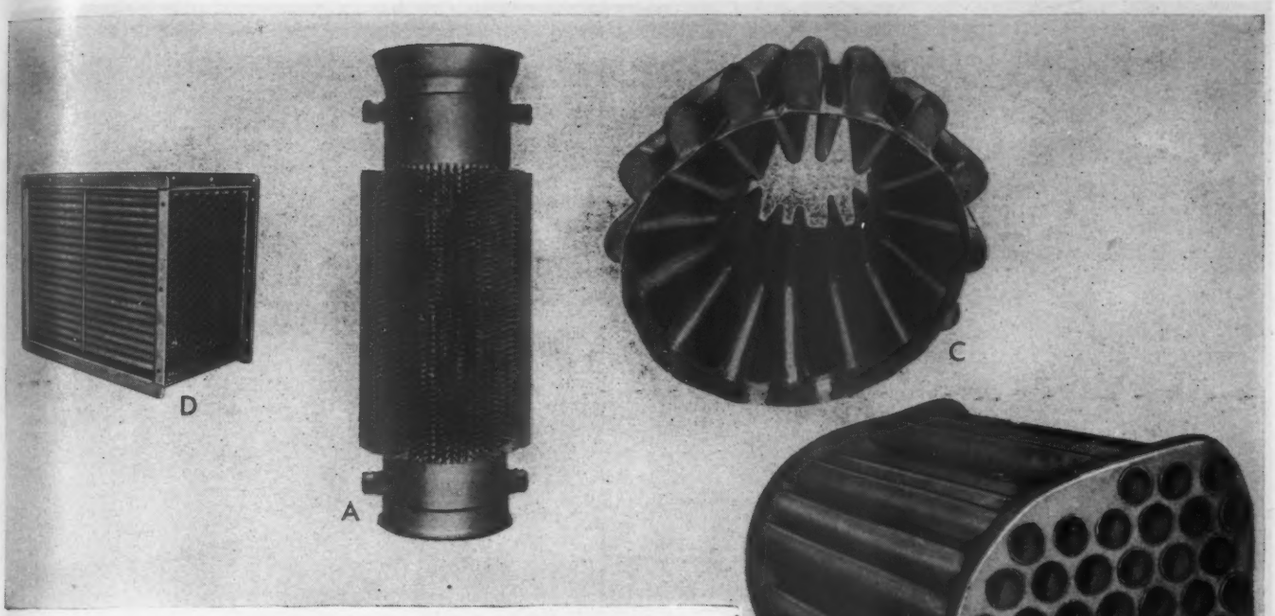
Stewart-Warner can recommend without prejudice. Because Stewart-Warner has a full line—not just a favorite to push. South Wind hermetic combustion heating, in many specially engineered forms, is serving on every battle-front—the most widely accepted aircraft heating equipment in the world.

In addition, Stewart-Warner has developed four different types of exhaust-gas heat exchangers. These new heat exchangers are the result of *two* special kinds of skill: *First,* Stewart-Warner *knows* combustion-gas heating from years of experience in making the heat exchangers which are a part of every South Wind combustion heater. *Second,* Stewart-Warner knows aircraft requirements and practices, from years of close cooperation with aircraft engineers.

Current development and design is based not only on advanced theory but on practical world-wide experience. Engineering facilities unheard-of in ordinary heating practices are employed constantly. . . . Facilities for producing exhaust gases ranging up to 3 million Btu/hr. per unit. . . . For simulating flight conditions above the ceiling of any known plane. . . . For delivering heating equipment to you with performance known in advance. . . . And, fully developed data on each type is available on request.

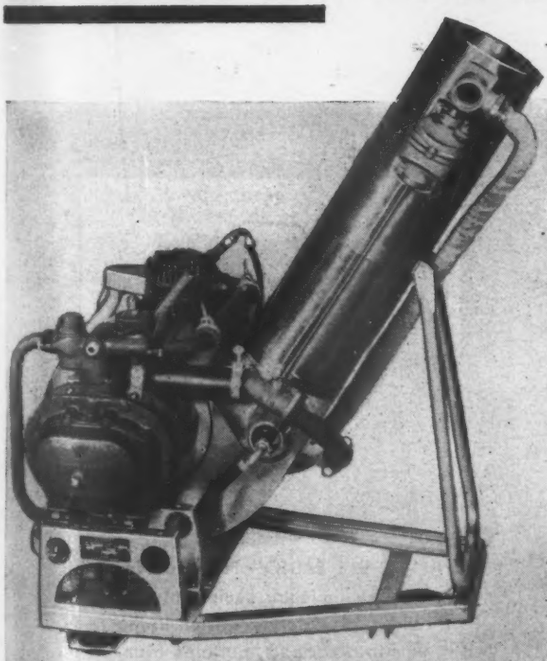
Thus, with by far the most extensive experience and most comprehensive line of combustion-gas airplane heating equipment in the field, Stewart-Warner can recommend impartially the heat sources best suited to your needs. And can engineer them in advance to the operating and installation conditions to be encountered.

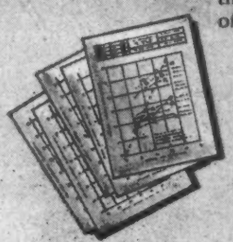
For an individual appraisal of your problems, write in detail.



Equipment YOUR WAY

Shown without shrouds are four basic types of exhaust-gas heat exchangers on which complete performance data is now available. The Extended-Surface (a), Tube-Bundle (b), and Hollow-Fin (c) types are planned for passage of all exhaust gas and extraction of only the required amount of heat. The Diversion-type (d) diverts only a fraction of the gas and extracts substantially all the heat. Each type has its place in the solution of heating problems.





Now available on each of above exchangers is full data and curves showing "Heat output vs. exhaust gas rate"; "Heat output vs. ventilating air rate"; "Pressure drop vs. exhaust gas rate"; "Pressure drop vs. ventilating air rate"; "Metal temperatures at all critical points under all conditions of operation."

Continued developments in South Wind hermetic combustion heating equipment are constantly meeting new demands for compact sources capable of delivering tremendous heat where, when and as needed. In a wide range of output capacities, and with accessory equipment to fit various special requirements, they meet problems unsolved by any other means.

South Wind HERMETIC COMBUSTION *Heaters*

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On a special mission, radio communication between plane and base may be limited to specified frequencies . . . during specified minutes. *That*, for the radio officer, means fast, accurate checking of frequencies.

With the "BENDIX" Frequency Indicator he accomplishes this with *laboratory precision* . . . adjusts his set, begins transmitting . . . in a matter of seconds.

Men and women of Bendix Radio take pride in knowing that receiving and transmitting equipment bearing the "BENDIX RADIO" nameplate is flying with our fighting pilots on all our vital battle fronts.

Products of the Bendix Radio Division are important members of "The Invisible Crew" . . . precision built instruments and controls which 25 Bendix plants from coast to coast are speeding to our fighting crews on world battle fronts.

"BENDIX RADIO" Portable Frequency Indicator Equipment provides laboratory precision in the air in a compact, portable form, over a wide range of frequencies.

THE INVISIBLE CREW
Precision Equipment by Bendix AVIATION CORPORATION

BENDIX RADIO DIVISION BENDIX RADIO

New Allied and Axis Planes

While the existence of the *Typhoon*, larger and faster brother of the *Hurricane*, was revealed this spring, there still nas been very little extra data available as to just what the plane can do. With the new 2,400-hp. Napier *Sabre* engine, a 24-cylinder H-type liquid-cooled engine, the plane's top speed is said to be well in excess of 400 mph., while it is armed with the largest number of cannon and machine guns ever carried on a single-engine airplane.

The Axis has shown up with some new wrinkles to an old theme too, a new version of the Me-109, the type G, was seen at the Russian front and shot down intact. It now has a 1,700-hp. liquid-cooled engine, but heavier armament and armor around pilot and fuel tanks brought the top speed down to around 335 mph. An improved FW-190 has also been reported from England, but as yet has not been observed in large-scale action.

In the bomber field, the Germans have been playing around with a number of high-altitude and performance planes, notably the four-engine, twin-propellered Heinkel bomber, which they claim has the same bombload as the Stirling, but up till now has stayed away from British defenses. The other plane is a revised Ju-86 with pressure cabin, which can operate at about 40,000 ft. The answer to this plane is coming off our production lines in the form of the P-47, which was designed for high altitude, not modified.

The Italians, feeling rather unhappy with their 1930 vintage biplanes, have been using the new Macchi 202 fighter illustrated in our September issue, which is said to give them back a little of their flair for flying. The light armament has made these planes an easy prey for Allied fighters, though.

A general survey made by Peter Masefield in England gave the Allies by far the best set of planes as far as heavy equipment, fighters and general utility planes are concerned. Only two Axis planes are mentioned in the line-up, the Do-217E-2 as the best medium bomber and the Italian Savoia SM-84 or 94 as the best land based torpedo plane. The new British and American planes now coming off the lines, combined with bigger and better guns and bombs like the recent four-ton blockbuster used by the RAF, should place us in a position to add measurably to the Axis' discomfort. As interesting as some of Mr. Masefield's candidates were some of his omissions—outstanding of which were the B-17 and B-24.

Details have at last been released about the Short *Stirling* heavy bomber, mainstay of the first large-scale British air offensive against Germany. Appearing in a recent issue of the *Aeroplane* is a set of impressions about this leviathan by one who should know, the late Capt. F. D. Bradbrooke, just released although written some 20 months ago, before he was lost in takeoff on his way across the Atlantic.

Capt. Bradbrooke was in charge of ferrying the *Stirlings* from plant to base fields and as such became closely familiar with them. The final summing up of this plane's qualities is a masterpiece in itself: "The answer must be, and is, that this aeroplane really flies itself, subject to adjustments by the mighty atom in the nose, who has the cards distinctly stacked in his favor. His muscular control is nominal only, but by good design these tons of metal are made intimately subject to some 6,000 hp. at his finger-tips. Let nobody say we have made no progress in aeronautical science, for this control business is a miracle by itself. Anway it gives the atom a mighty nice feeling."

Specifications of the Short S-29, or *Stirling I*, equipped with four Bristol *Hercules VI* motors, totaling 6,400 hp., are as follows: span 99 ft., length 87 ft., height 22 ft. 9 in., empty weight 46,000 lb., gross weight (normal) 70,000 lb., maximum bomb load 17,000 lb. Maximum speed over 265 mph. at 14,000 ft., and range over 2,000 mi. at 225 mph. plus.

U.S.-British Cooperation

A Controller of American Supplies and Repairs has been appointed in the British Ministry of Aircraft Production, and Lt. Col. Lord Burghley has been entrusted with this office which is bound to increase in importance as more and more American aircraft arrive in England.

The new controller will not concern himself with supplies for the USAAF stationed in the British Isles, as its units provide their own ground crews, mechanics, armorers, and defense units on the RAF aerodromes which they have taken over. The problem of American supplies and repairs is one that requires intimate British-American cooperation, and Lord Burghley will act as chief liaison officer between the two services.

Special Propeller

A special propeller for trainer airplanes is now in production by the Rotol Company. Hydraulically operated and full-feathering, the blades are made of specially treated wood, easily repaired, and weigh only 110 lb.

Lancaster Production Details

The *Lancaster* follows the rules laid down for most heavy aircraft, being built up in three main divisions — fuselage, wings and tail, which in turn consist of 36 subassemblies, 6 for the fuselage, 8 for the tail, 1 for the tail turret, 17 for the wings and 4 for the engine nacelles. Only one in ten of the workers employed is skilled, and four out of every ten are women, working an average of 64 and 57 hr. on alternate weeks.

A saving in labor results from the use of special castings for the landing gear, and while construction details mostly point to the wish to facilitate production, this has been achieved without detracting in any way from the operational value of the plane.

British Combine

POISON FOR THE AXIS

Pvt. L. H. Portong of the Army Air Forces in England proudly displays to an RAF colleague the heavy calibre guns mounted in the ball turret of a Boeing B-17. Such guns—together with the many others mounted on all sides of the American bombers—have proved particularly effective in establishing an amazing record against Germany's best fighters.

Canadian News

By James Montagnes

Private flying and the making or servicing of aircraft for private flying have been drastically curtailed in Canada. An order of Ralph P. Bell, aircraft controller, limits the manufacture or assembly of aircraft in Canada to the fulfillment of orders placed by the government, and to the fulfillment of any other orders approved in writing by the comptroller. It provides that, except on instructions from the aircraft controller, no person shall incorporate or introduce any modification, change, or addition into any aircraft made for the government. No repair or overhaul contractor may employ government facilities for work on airplanes other than those owned by or under control of the government, except by permit.

Oil Controller G. R. Cottrelle, in an order to conserve aviation gasoline for the air forces of Canada and her allies, grounded all nonessential aircraft on Sept. 30. Except by permit in writing, no person may use any petroleum product for the operation of any type of aircraft. Only flying permitted now in Canada is by the aircraft of the armed forces of Canada and her allies, aircraft operated for the RAF and RCAF combined air training organizations whether government or privately owned, any scheduled air transport service licensed with the Department of Transport, essential services such as forestry patrols, nonscheduled air transport to outlying districts otherwise inaccessible, essential mining and exploration, aerial photography and surveys approved by the government, aircraft and engine testing by manufacturers, and pilot training

for essential civil and commercial services. Pleasure flying is out for the duration.

Canadian commercial passenger aviation is climbing by leaps and bounds, according to figures released by the Dominion Bureau of Statistics, Ottawa, latest figures cover the first five months of 1942, and show that in May, 1942, the number of passengers carried was 20,810 compared to 15,311 in the same month last year. Mail increased in May, 1942, to 374,176 lb. from 274,748 lb. a year previous. Gasoline consumption for the same period jumped from 376,833 gals. in 1941 to 419,706 gals. this may. Revenues of licensed operators increased from $704,705 to $903,197, and operating expenses from $624,474 to $819,317. The number of employees increased from 1,604 to 1,941 and the payroll from $244,098 to $326,232. Only drop was seen in air freight carried, which dropped from 915,353 lb. in May, 1941, to 743,936 lb. in May, 1942, largely because of the closing of some remote gold mining areas due to the war.

The Munitions and Supply Department at Ottawa announced that the government-owned Federal Aircraft Ltd., had delivered the 1,000th Avro *Anson* produced in Canada in 1942, just a year after the first ship came off the assembly line. The Canadian *Anson*, a counterpart of the British Avro *Anson*, is a light reconnaissance twin-engined bomber used as an advanced trainer. It requires 15,000 man-hours to build, and molded plywood plays an important part in its construction. Federal Aircraft works in conjunction with a number of aircraft companies throughout Canada, and assembles the *Ansons* at strategic points in the Dominion. It also makes spare parts for maintenance of British Avro *Ansons*, which Britain shipped to Canada early in the war. W. A. Newman, chief mechanical engineer of the Canadian Pacific Railway, was recently appointed president of Federal Aircraft, with Ray Lawson of London, Ont., former president, becoming chairman of the board. Ralph P. Bell, aircraft controller for Canada, was first president of the company when it was formed in 1940.

A training device which simulates the flying of a twin-engine aircraft the way a Link trainer simulates the flight of single-engine aircraft has been perfected by a trio of men in Canada—Allan Wright, union organizer of the Pacific coast, now in the RCAF, and two pioneer RAF civilian ferry pilots, Captain W. C. Siple of Norwich, Ont., and Russell West of Florida. Orders have been placed by the Department of Munitions and Supply, Ottawa, for the new training device, and the trio expect to start development work on several other aviation devices as soon as the training machine is in production.

Limitation of aircrew recruits to a maximum height of 6 ft., 2 in. and weight to 210 lb. has been lifted by the RCAF. Larger bombers, with increased space for crew members, resulted in the change of policy. A new rank of flight engineer has been opened by the RCAF in Britain with the conversion of the senior Canadian bomber squadron to four-motor *Halifax* bombers. The flight engineer's job will be to keep the gasoline flowing to the four engines and to watch all engine instruments. Former ground crew members such as fitters and riggers can qualify for the new rank and wear the flight engineer's wings.

ON SCHEDULE . . . by "Vista"

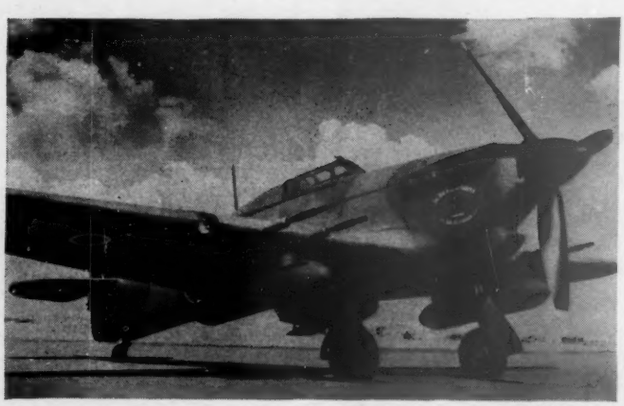
The Vichy French Airlines, already in bad shape thanks to the good services of Nazi Germany, went from bad to worse according to recent news coming from Europe. All lines inside the unoccupied zone have been cancelled due to a shortage of fuel, pilots and equipment, while only the Marseilles-Algiers-Tunis line is being maintained on a weekly schedule to ferry French and Nazi bigwigs. Around the end of September, all Allied citizens were barred from such French services as were still being operated, and on the same day a plane of the Marseilles-Tunis service made a force landing with 25 important passengers, but caught fire and burned up before coming to a stop. To offset this bad news, it was announced with some fanfare that the French would soon open connections with Sweden and the Channel Islands— the Sweden service looks unlikely and the Channel line is already maintained by Britain and America on regular schedules.

Interesting also is the little item from Russia which tells that no complete Nazi planes are being produced in France any more, the poor quality and excellent sabotage being more than they could cope with.

News from Britain is both good and bad too—British Overseas Airways lost the *Clare* a Short flying boat which had had many adventures during her four year existence. Also lost in the Middle East was Wing Comdr. G. H. Stainforth, famous Schneider cup winner and speed pilot, and one-time holder of the world's speed record. At 43, he was one of the oldest pilots in active RAF service, and engaged on night fighter duties.

On the other side of the ledger stands BOAC's successful use of converted Whitley bombers on regular cargo lines in the British Isles and elsewhere in the Empire, and its maintenance of a network connecting all spots where Englishmen are found under conditions which would make many other operators wince. To cope with the ever increasing cargo quantities, large cargo carriers have been ordered from several manufacturers, and soon will come rolling off the production lines.

Over Guadalcanal American Grummans brought down a German-looking airplane with Jap markings, from all indications a Messerschmitt 110, but as yet unconfirmed.



British Combine

DESERT FIGHTER

A Hawker "Hurricane" fighter armed with four 20-mm. cannon in service with the RAF at a desert base. The long distances involved in this theater of war require addition of extra gas tanks, seen slung beneath the wing. The "bugaboo" of all desert fighting—sand—has made it necessary to raise the air intake as high as possible and bring it up close to the propeller.

Swedish Built Warplanes

A new aircraft plant, the second, will be started in northern Sweden to meet growing demands of the Swedish air force. New types have been designed to meet the peculiar operating conditions, and a fighter of Swedish design will be ready for quantity production early in 1943. The strength of the Swedish air force is now 16 wings, including 6 bomber and 6 fighter wings.

Ju-52 As a Test Stand

A new use has been found for the tri-motor Junkers Ju-52 in Germany, where the plane is now being used for testing new engines. The aircraft engine which is to be tested is mounted as the center powerplant, so that the test pilot can switch off the experimental motor if necessary. The cabins of these Ju-52's have been converted into "flying test stands" and are equipped with all the necessary gages and instruments. The test flights are usually carried out at predetermined heights, and as the plane may have to fly through cloudbanks, a full complement of radio and blind flying equipment is carried.

Swiss Plans

While Swiss civil aviation is at present limited to the airport at Zurich, large fields have been projected for Basle, Geneva and Berne, and 20,000,000 francs have been allocated for this program. Moreover, a central airport for international and trans-Atlantic services may be built, even though it is not expected that Switzerland will become a major air junction. While existing meteorological conditions will make most planes avoid the country whenever possible, tourists and commercial travelers are expected to show increasing interest in the country.

BUY U. S. WAR BONDS — *REGULARLY* EVERY PAY DAY

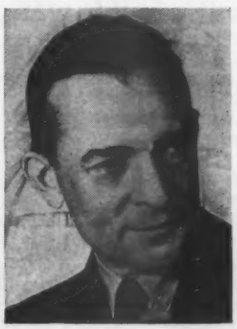
THE LOUIS ALLIS CO., MILWAUKEE, WIS.

RUSSELL NEWCOMB, J. "JIMMY" ALLEN (center) and JOHN W. OVERBEKE of Simmonds Aerocessories. Russ Newcomb, formerly of "Air Youth," and more recently of "Wings," the magazine of the Bureau of Aeronautics and the Army Air Forces, is the new advertising and promotion manager. Jimmy Allen is the newly appointed administrative engineer. He has been in aircraft engineering for the past 17 years and has been with Vultee, Northrop, Douglas and Ford before joining Simmonds. Mr. Overbeke is newly appointed chief engineer and was for a number of years design engineer in charge of hydraulics for Glenn L. Martin, when he assisted in the design of the "Mars," B-26 and other planes.

B. R. SHERRELL, who was production manager, assistant works manager, and subsequently works coordinator of Vultee's Inland Division has been named works manager of the division in charge of all shop and outside work.

AMOS CULBERT has resigned as vice-president and general counsel of Chicago & Southern Air Lines to go with American Airlines as a vice-president. He is president of the Airline Finance and Accounting Conference of the ATA.

ELEANOR HAYNER who has been with TWA as reservations representative for the past year has been named head of the reservations department, a position formerly exclusively held by men. Among many other positions she was traffic manager for the United Artists organization.



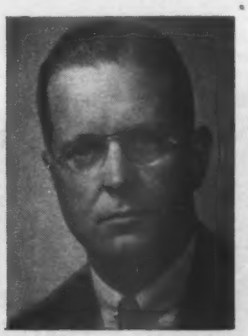
REGINALD EVERETT GILLMOR, president of Sperry Gyroscope, has been elected chairman of the executive committee of Fairchild Engine & Airplane, of which he has been a director since 1941, according to an announcement by Fairchild President J. Carlton Ward.

CLAYMAN C. SHAFER, senior industrial engineer of the Methods and Controls Dept. of Vultee, has been elected president of the Los Angeles chapter of the recently formed Society of Aircraft Industrial Engineers. National in scope, applications for additional chapters have been received.

ZEUS SOUCEK, who established two world's aviation records while flying for the Navy, has been elected vice-president and Washington representative for Brewster. Before joining Brewster, he was executive sales engineer for Eclipse Aviation and vice-president of W. L. Maxon.

REGINALD "REX" CLEVELAND, industrial advertising manager of the New York Times is the author of American Fledges Wings, the story of the Daniel Guggenheim Fund for the promotion of aeronautics and how it has contributed to America's leadership in aviation.

HARRY R. BRASHEAR has joined the staff of the Aeronautical Chamber of Commerce to organize a traffic department which will coordinate the work of traffic departments in the aircraft industry to the end that the industry and its customers will profit.



WILLIAM T. HEDLUND, who has been a director of Elastic Stop Nut Corp. has been named president of the corporation, and THOMAS H. CORPE (right), formerly of Lockheed, has been appointed General sales manager. Mr. Hedlund was formerly vice-president of Electrolux, in charge of engineering. Mr. Corpe was one of the ranking aces flying for the Allied forces in World War I, has 22 enemy aircraft to his credit, and is the proud possessor of the Military Cross, Distinguished Flying Cross and Croix de Guerre.

D. B. WALLACE has been appointed asst. to the vice-president and general manager of Canadian Pacific Air Lines. He is a special representative of Canadian Pacific Railway, and prior to his appointment was on loan to the British government.

HAROLD R. HARRIS, vice-president of Panagra, has been commissioned a Colonel and will be stationed in Washington as the Plans Officer on the Staff of the Commanding General of the A.T.C., one of only three who have achieved this rank direct from civilian status.

Task Force

The first essential "task force" of military aviation is composed of the primary flight instructor and his student. Their mission is TRAINING. At Ryan schools in Hemet and Tucson, the skies are filled with "task forces" hell-bent on the very best pilot training in the world today. The *esprit de corps* at Ryan training centers has become traditional. It emanates from the entire organization and inspires instructors and cadets alike. Translated into later combat action, it's the high efficiency and tough determination that will win this war.

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. . . says Paul Sanger, Flight Instructor at the Ryan school, Tucson. He was chosen by his fellow workers to interpret their spirit of teamwork for victory.

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DEDICATED FOR THE DURATION TO THE EXCLUSIVE TRAINING OF ARMY PILOTS

American Airlines reported earnings of $1,205,318 or $1.91 a share on the common stock for the six months ended June 30 as compared with net of $866,717 or $1.32 a share in the like 1941 period. The excess of proceeds over book value involved in the involuntary conversion of aircraft to military service in the amount of $1,140,722 will be credited to a replacement reserve for the future acquisition of aircraft equipment.

Transcontinental & Western Air, Inc., reports net income of $498,216, after charges and taxes, equal to 52c. a share, for the six months ended June 30. This compares with a net loss of $693,049 for the same period a year ago. The increased revenue was due in part to greater passenger traffic moved with fewer flights, coupled with a large increase in express movement which, for the January-August period, was 135 percent greater than the corresponding 1941 period.

Bendix Aviation is reported negotiating with a group of 35 banks for a $200,000,000 "V" loan to finance the company's huge war business whereby sales have risen from $125,000,000 to around $360,000,000 in one year's time. Proceeds from the initial portion of the credit is expected to be used to liquidate current accounts payable which have jumped to about $35,000,000 from $8,600,000 a year previous. This line of credit would be by far the largest ever established in the aircraft industry.

Northrop Aircraft has obtained a $17,000,000 credit from a syndicate of banks, according to La Motte T. Cohu, chairman, who pointed out that expanded activities make it advisable for the company to make use of available bank credit. The loan was arranged under regulation V of the Federal Reserve Board and is secured by assignments of the proceeds of certain production contracts. It was reported in Wall Street recently that Fairchild Engine & Airplane Co. also is negotiating a bank credit.

United Air Lines third-quarter traffic figures reveal that revenue passenger miles were off only 15 percent in the first full quarter of regular operations with reduced equipment —its fleet in the September quarter being less than half as large as a year ago. Yet mail operations were up 67 percent and express jumped 152 percent over a year ago. Peak loads on present equipment, elimination of passenger discounts and the absorption of overhead by planes operated for the armed forces, it is understood, have had a favorable effect on earnings.

Menasco Manufacturing Co. reports net income of $334,692 after provision for taxes totaling $726,000, for the fiscal year ended on June 30, 1942, equal to 36c. a share on the 925,000 shares outstanding. Working capital was listed at $487,132 with cash in banks and on hand amounting to $781,201. Earned surplus was $35,612. Sales totaled $4,869,695 and current assets as of June 30 totaled $2,567,559 and current liabilities $2,080,427. Losses written off totaled $367,386 and indebtedness liquidated included all bank loans and funded obligations leaving the plant free of mortgage. Obligations owing to the Lockheed Aircraft Corp. were reduced $1,535,071. Current advances on contracts total $129,892.

Eastern Air Lines is following the War Department ruling which makes it possible to suspend quarterly earnings reports but it is reported in well informed circles that revenues in September were abreast of those of the like 1941 month while the load factor has been running around 80 percent occupancy of all available seats in strong contrast with a 55 percent load factor a year ago. The result is that the line's regular commercial operations are producing twice as much revenue per plane due to stimulated war traffic.

Beech Aircraft Corp. declared the first dividend in the company's history on Oct. 7 when a payment of $1 a share was ordered by the directors to be paid to shareholders on Oct. 27. According to Wall Street estimates, earnings for the fiscal year which ended Sept. 30 may have reached $7 a share on the 400,000 common shares outstanding as compared with a net profit of $471,715 or $1.17 a share in the preceding year. Preliminary estimates are subject to year-end adjustments.

Brewster Aeronautical officials have been granted a stay until Nov. 2 of all court proceedings in a $10,000,000 stockholders' accounting suit brought against former officers and directors. The stay was sought by the present management on the ground that additional time was required to study the issues involved and to determine what course to take in the best interests of the company and its stockholders.

Harvill Aircraft Die Casting Corp. has declared a stock dividend on its capital stock equal to 10c. a share payable in new 6 percent preferred stock which was recently authorized by stockholders. At the same time it was announced that F. M. Hoefler, formerly vice president, had been named president and that Warren Stratton, Los Angeles attorney, had been elected a director.

Bendix directors have postponed the next regular meeting from Oct. 28 to Nov. 24 at which time the dividend action usually taken in October will be up for consideration. In this way added time will be given the board in which to determine dividend policy in the light of tax legislation and contract renegotiation developments.

Beech Aircraft has started negotiations looking to the purchase of the emergency plant facilities constructed for the company with federal aid, according to reports from Kansas City. If negotiations are successful Beech would be the first aircraft concern to take advantage of defense plant contracts whereby companies are permitted to acquire title prior to the end of the five-year amortization period. The property is carried on the company's books at about $2,700,000

Northwest Airlines turned in record-breaking profits in the fiscal year ended June 30 when net earnings amounted to $430,100 or $1.83 a share compared with $327,495 or $1.39 a share the preceding

★ ★ ★ By RAYMOND HOADLEY ★ ★ ★

ALTHOUGH it seems quite probable that a number of aircraft manufacturers, if not the majority, will show somewhat smaller earnings this year than in 1941, it is altogether possible that these same companies may experience another upturn in earnings again in 1943. At least that is the plausible theory advanced in some Wall Street circles where it is pointed out that corporate taxation is now approaching its maximum while aircraft production will continue to new record levels next year.

However, the main worry of the aircraft producer these days is not earning power, strangely enough, but working capital. If General Motors Corporation with its tens of millions of liquid cash assets finds it necessary at this time to negotiate a $1,000,000,000 line of credit with the banks and the government, it stands to reason that many aircraft companies now making up the nation's Number One industry may well be in the same position. Today the value of aircraft production tops that of even the giant steel industry. But should the war stop tomorrow most aircraft companies would have their funds tied up in inventories and their earnings subject to re-negotiation for another three years. Consequently, it is considered a healthy sign that several aviation concerns, as well as other war industries, are turning to regulation "V" loans to obtain working capital. Instead of the separate and complicated negotiations on each contract necessary to obtain government advances, companies securing the V type loan get a credit which can be drawn upon quickly for any production needs without regard to individual contrasts.

This is how it works: the contracts form the collateral for the banks, the banks are guaranteed by the Federal Reserve which, in turn, is guaranteed by the Army or Navy against loss in event of cancellation of contracts when the war is over. The motor car companies are accumulating some of the aircraft industry's "know-how" in a common war effort and they are also negotiating huge bank loans to maintain their working capital position. When peace comes the aircraft companies will want to be equally "well heeled" financially in order to meet any competition that the automotive group may offer.

Fortunately for the aircraft makers, the government appears to be slowly changing its attitude toward re-negotiation of contracts. The voluntary price reductions which a number of companies have been able to pass along to the government because of mass production economies have done much to create this more favorable attitude. Congressional committees and some federal officials are beginning to see the need for aircraft companies to earn sufficient profits to maintain strong financial positions.

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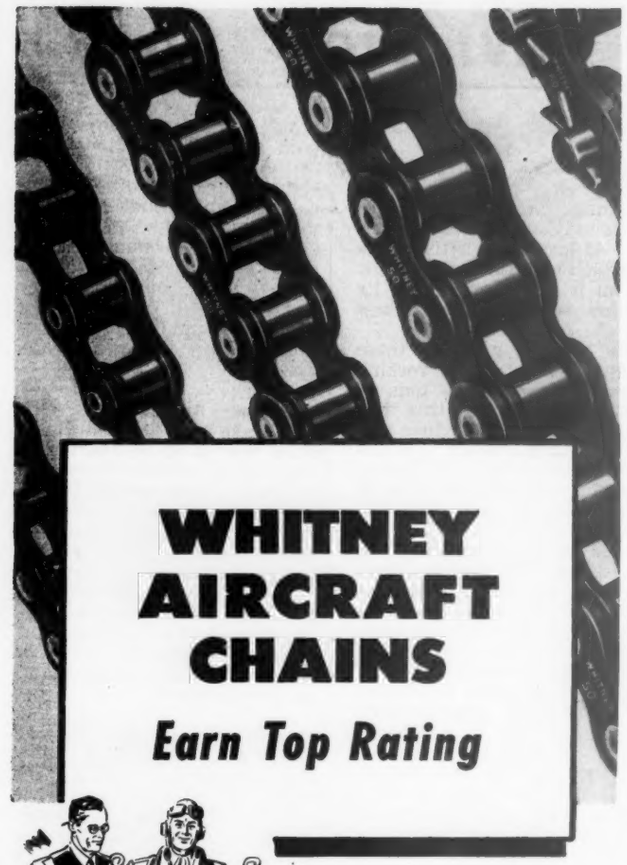

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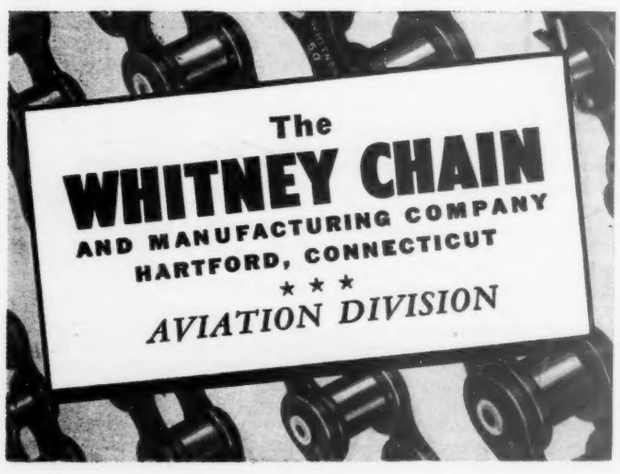

year. During the fiscal year bank loans were reduced by $242,500, bringing the figure down to $142,500 on June 30. Since then bank loans have been reduced to only $30,000. At the September annual meeting stockholders were asked to approve the elimination of all authorized preferred stock, none of which is outstanding.

Chicago & Southern Air Line's most successful year resulted in conversion of a surplus deficit of $51,307 on June 30, 1941, to a positive figure of $96,020 on June 30, 1941. Net earnings in the 1942 fiscal year amounted to $128,959, or 60c. a share compared with a loss of $111,931 in the preceding year. A dividend of 50c. a common share was declared out of the earnings for 1942.

American Central Mfg. Co. directors have not decided upon a regular common dividend policy but will make such disbursements as seem prudent in light of the necessity for conserving working capital. The company earned $475,638 in the nine months to Aug. 31 compared with $46,439 in the like 1941 period.

Solar Aircraft Co. reported net income for the three months ended July 31 amounting to $162,421 or 43c. a share in contrast to profits of 78c. a share for the full fiscal year ended Apr. 30. During the July quarter "V" bank loans totaling $2,000,000 were reduced by payments of $93,559.

ON THE RAW MATERIALS FRONT

Seven important magnesium plants have entered production in recent weeks. Magnesium is "aluminum's twin" in airplane production so the completion of these plants in record time represents another milestone passed in the preparations for the huge warplane output of 125,000 units scheduled for 1943. The largest of these plants, that of Basic Magnesium, Inc., in Nevada, has a rated capacity approximately 3½ times the total U. S. output in 1941. Also in operation is the new Southwest plant of Dow Chemical Co. which, up to now, has produced all but a negligible amount of this country's output of this lightest-of-all metals. Both Dow and Basic use the standard electrolytic processes.

Other concerns with new plants in operation this fall include Ford Motor Co., New England Lime Co. in the East, Permanente Metals Corp., in the West and Diamond Magnesium Co. in the Midwest. All these plants have been started since Parl Harbor and were financed by the government through Defense Plant Corp. The first three just mentioned use the new ferrosilicon process developed within the last year.

At the same time Canadian-made magnesium is available for the first time. Canada's entry into the field is based on discovery of a completely new extraction method applied to large but little-worked dolomite deposits in the province of Ontario. The Dominion Magnesium Co. is operating the government-financed project, using the thermal process to extract the metal from the dolomite ore. Eventually, it is estimated, 40,0000 lb. a day will be produced. Up until now Canada has depended on the United States for its magnesium but this new production will go a long way toward meeting the Dominion's own needs for its expanding aircraft program and relieves a shortage that would soon become acute as airframes roll off Canada's assembly lines in increased tempo.

Including Canada's $5,000,000 plant, the seven new plants in North America have been erected at a total cost of $200,000,000. Three more ferrosilicon plants are nearing completion and will commence operations before the year-end. An additional four electrolytic plants are now under construction. Union Carbide & Carbon Corp. and International Minerals & Chemical Co. will operate several of these new units.

Completion of the program will place the United States far in the lead of all other countries as a magnesium producer, according to war production officials. Germany was the world's leader before the war. Less than five years ago Dow Chemical, the pioneer in the field, was producing less than 6,000,000 lb. of magnesium a year and the metal, ironically enough, was a drug on the American market. Some was exported to France and a lot more was put in warehouses.

Today the program calls for 725,000,000 lb. annually early next year—more than 100 times greater than the highest prewar production. Soon there will be more magnesium and aluminum in this country than there was copper and zinc a couple of years ago. And this big volume production is having the usual effect on prices. Magnesium has come down from 37.5c. per lb. to 22.5c. And it bids fair to offer the liveliest sort of postwar competition for some of the other metals.

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Recent Books

HANDBOOK OF WAR PRODUCTION, *by Edwin Arthur Boyan. Published by McGraw-Hill Book Company, New York. 368 pages, charts, appendices, index. $3.00.*

From interviews with more than 200 government officials and manufacturers already engaged in war production, Prof. Boyan of the Massachusetts Institute of Technology has produced a lucid, immensely practical study on exactly how plowshare manufacturers can get into the sword business.

For managers of large and small plants he has analyzed the specific steps required in procurement of contracts, conversion to war production, procurement of materials and supplies, production planning and control, labor and expansion, quality control of war production, conservation of strategic materials, industrial accounting in wartime, estimating for war contracts, and planning and control in subcontracting.

Warnings on pitfalls and specific suggestions on solving these problems are illustrated with frequent references to experiences of companies now producing weapons. Prof. Boyan recommends the alertness responsible for their success to all manufacturers: accurate accounting and appraisal of plant facilities, close contact with government and manufacturers under similar contracts, and constant, careful check on scheduling and progress of operations through Gantt Progress and other charts.

"Know where you are going, and move heaven and earth to get there," advises one manufacturer. This book is a detailed, useful elaboration of this general instruction.

THEORY OF FLIGHT AND AIRCRAFT ENGINES, *by Bert A. Shields. Published by McGraw-Hill Book Company, New York. 377 pages, appendix, illustrations, and index. $2.75.*

METERORology AND AIR NAVIGATION, *by the same author and publishers. 285 pages, appendix, illustrations, and index. $2.25.*

These revised, companion volumes, issued under the general title *Air Pilot Training,* are designed, says the author, to give student flyers "all the information necessary to pass the written examinations for a private and commercial pilot license."

Theory of Flight and Aircraft Engines are two sections of one book: the first reviews the hows and whys of planes in flight and the second describes the details of the engines which keep them there.

Likewise, *Meteorology and Air Navigation* is divided into two parts. From the theory of weather (the atmosphere, air currents and masses, and fronts and related air movements) the student progresses to the practical uses of maps and charts, the compass, radio navigation, drift problems, air-navigation computers and graphs, and finally gets a peek at celestial navigation.

Both books are simply written, practically devoid of technical terms, and contain review questions helpful in brushing up for government examinations.

AIRCRAFT RIVETING FUNDAMENTALS, *by George E. Tabraham. Published by the Bruce Publishing Company, Milwaukee. 31 pages, illustrated, paper bound, 50c.*

Elemental facts for student riveters presented in simply illustrated, briefly written lesson sheets to accompany step-by-step shop instruction. For beginners only.

TENTATIVE STANDARDS AND RECOMMENDED PRACTICES AND PROCEDURES FOR SPOT WELDING OF ALUMINUM ALLOYS, *published as an emergency standard by the American Welding Society (New York) with the approval of the National Aircraft Standards Committee. 48 pages, illustrated, paper bound, $1.*

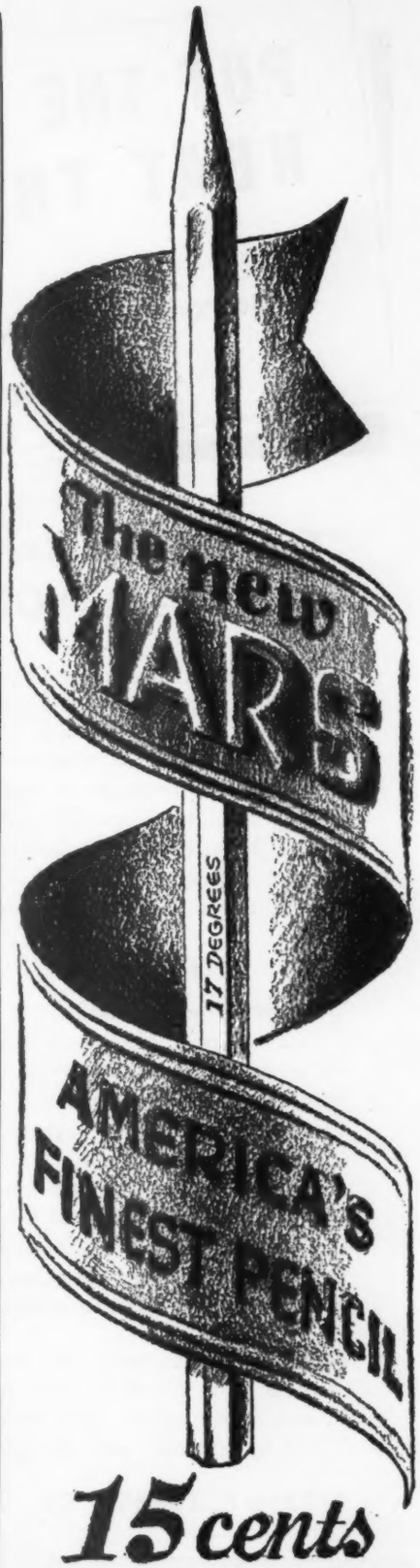
Covering an ever-changing subject, this brochure provides aircraft fabrication men and "welding engineers" with the latest available dos, don'ts, and developments in surface preparation, standards of welding quality, technique, testing, and inspection of resistance welds.

It was prepared by a committee of welding specialists (most of them in aircraft construction) who request all manufacturers to keep them posted on further developments which should be incorporated in future revisions of this paper.

FRONTIER BY AIR (BRAZIL TAKES THE SKY ROAD), *by Alice Rogers Hager. Published by the MacMillan Company, New York. 243 pages, appendix, index, illustrations, $3.50.*

Popular, personal reminiscences of a government-provided air inspection of Brazil in the summer of 1941.

Most valuable, however, is a 48-page appendix filled with facts and figures on Brazil's promotion of aviation, pilot training, mail, cargo, commercial, and military flying, and aircraft production. Mrs. Hager has also appended detailed



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information on various stops in her 15,000-mi. itinerary, and her traveling companion, female photographer Jackie Martin, has provided plenty of pictures.

TRUE STEEL, *by Christy Borth. Published by the Bobbs-Merrill Company, Indianapolis. 319 pages, index, illustrations, $3.00.*

A competently written biography of George M. Verity, able man of foresight in industrial research and sympathy and understanding for his employees who guided the American Rolling Mill Company to a prominent place in the steel industry.

THE FLYING TIGERS, *by Russell Whelan. Published by the Viking Press, New York. 224 pages, recapitulation of statistics and personnel, illustrations, $2.50.*

A day-by-day, occasionally labored account of how 47-year-old Claire L. Chennault of Waterproof, La., retired from the Army Air Corps for partial deafness, and his American Volunteer Group defending the Burma Road brought down an official 286 Jap clay pigeons and perhaps 300 more probables in little more than six months.

Against 1,500 enemy casualties, the AVG, which never had more than 55 flyable, outdated P-40's, lost 8 killed and 4 missing in action, 12 in bombings and accidents. So effectively did only 70 pilots buzz that the Jap radio bolstered its courage with the boast: "Our heroic warhawks have destroyed 2,000 AVG planes."

"It was the finest flying I've ever seen," said an RAF pilot. "Those Americans are simply wizards."

THE STORY OF THE AIRSHIP (NON-RIGID) *by Hugh Allen. 74 pages, illustrated, indexed, $1.00 from The Goodyear Tire & Rubber Co., Akron, Ohio.*

A sketchy history of blimps to prove them the most efficient weapons in combating coastal submarine attacks. Navy airships can now radio "sighted sub; sank same," goes the burden of this message. A special presentation of interesting, historical facts seeking special praise, pleading a special (and now recognized) cause.

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Builds the parts for America's Air-mada

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But before the planes (and Victory) must come the parts—wings, fins, tail surfaces, ailerons, stabilizers, fuselage sections, and more.

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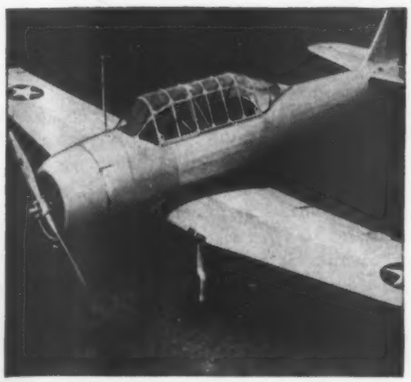
FLEETWINGS

pioneers with parts and hydraulic equipment



The BT-12, all-welded basic trainer built for the U. S. Army Air Forces.

TO "KEEP 'EM FLYING"—In addition to building myriad aircraft parts for other manufacturers, Fleetwings also builds *complete* planes. The Fleetwings-designed-and-built BT-12 has more than proved the mettle of stainless steel for military aircraft. (Incidentally, the BT-12 is the *first* all-welded military plane constructed principally of stainless steel.)

LEAVE IT TO FLEETWINGS—to give a new "twist" to the nation's scrap-saving program. In the Fleetwings plants, there's an active campaign *to keep scrap from becoming scrap!* Vital plane hardware—nuts, bolts, rivets, clecos, and washers—is being conserved through a company-wide program which stresses that "every rivet is a bullet" and that plane hardware should be treated as though it were rationed ammunition—and not to be left where dropped.

OVER 1100 HOURS—were saved on a recent job at Fleetwings through the use of a new and simplified Template Reproduction Process. Another example of how Fleetwings is speeding plane and plane parts production.

ANOTHER FLEETWINGS ADVANCE—is the use of isometric, three-dimensional graphic illustrations along assembly lines to speed and facilitate production of airplane surfaces. These graphic illustrations, made in our Tool Design Department, show the exact position and procedure for every nut, bolt, rivet, washer, etc. and greatly simplify assembly work for men with little or no training in the reading of blueprints.

"KEEP 'EM FLYING!"

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America at War

(*Continued from page* 93)

The hardest of all engineers' jobs is to build adequate fighter planes. The fighter plane must compromise every one of its functions, and yet it must approach the impossible in every one of them. (See Factors Controlling Aircraft Design and Combat performance, page 96). So the designers, seeing the high-flying B-17 going it alone and knocking the fighters down in the bargain, are wondering if, just perhaps, they might some day be told to skip the superduper fighter and concentrate on pure destruction. That's not a prediction; it's only an idea lurking in a few heads.

A *Fortress* has more guns than you have fingers and thumbs; it is ruggedly armored in the right spots; still, it's fast and agile, and can fly very high. It escapes most of the ground fire. It faces mainly air attack. But think what the attacker is up against. A fair formation of B-17's would have a hundred or more guns, with an awful lot of them able to play in any direction. The attackers can figure on getting hit just about as they would by drops of water in a rain storm.

High Level Bombing Gains

This is not meant to sound optimistic. The Germans know a lot about high level bombing by now, and they will try to catch up with our lead as fast as they can. It will be hard for them, because, in that particular line, we are ten years in front. Incidentally, when Boeing submitted this bomber, only two or three Army men approved of the idea, and one of them was Gen. Frank Andrews, formerly chief of the Air Corps, and now in command of the Caribbean war zone. The British now say that Boeing "made a daring experiment" and on that point you may want to agree with them.

The performance of the B-17 leads to a word about the performance of American planes in general. There have been a *lot* of words on that subject lately, for better or worse. Some people think the criticism, sometimes uninformed, sometimes prejudiced, was nevertheless a good whip cracker for the fuddy-duddies. Others think all the talk unnecessarily demoralized the people, who are paying more billions now for airplanes than the total of the national debt just before the war. Especially it dampened the fighting spirits of some of our pilots, who thought they were getting let down by the boss men.

Anyway, Congress took an interest in all the noise, and the House Military Affairs Committee called in plenty of aircraft and military men who know what's going on and why, and got the whole story. The committeemen heard all about the mistakes that have gone under the bridge, and skipped them. Much detail of interest is included in the report but in the end the committee came to an especially interesting conclusion—precisely the same one that has been stated many times by officers and others responsible for the hitting power of our airplanes.

The committee said: "In the final analysis, it is the box score that counts. It is idle to compare the speed, performance and maneuverability of one plane against another when engaged in war. These in actual combat are academic questions. It is only common sense to say that our planes and our pilots are performing exceptionally well when they are knocking down two or three enemy planes to every one of ours that is lost."

It is too bad that all the work of our various planes cannot be reported in this space, but they have to take their turns as they pop into the news. One other, which may show up in heroics some time soon, is the Martin B-26 medium bomber. As you know, it has already served to a nicety as a torpedo plane against the enemy in the Pacific, and perhaps elsewhere. Now it's been up to other new departures, which cannot be told as yet. The enemy doesn't like this plane at all.

But don't believe that you will hear about all the air developments, not even all the important ones.

New Fighters In Action

You should hear more, before long, about our newest fighter planes, which are arriving at the front. The Lockheed P-38 interceptor is frequently reported; a number of the Republic P-47 *Thunderbolts* are understood to be in action by now, but nothing has been reported on the Navy's Vought-Sikorsky shipboard fighter, the F4U. All of these planes have 2,000 hp., equaling the world's best. They have what their designers think is the best possible combination of all the features a fighter should have. We have still other new planes, going toward production, not yet heard of.

But not all the air war news is good. Adm. Thomas C. Hart, former commander of the United States Asiatic Fleet, said in a *Saturday Evening Post* article that our aviation made strategic mistakes when the Jap war started, and that our fighter planes missed their chance at Pearl Harbor and Luzon. He said that our submarines bagged as many enemy ships as all other forces combined. He also explained how the British lost their two battleships to Jap air attack. The commander knew the risk, but if he had got through he could have knocked off Jap merchant ships carrying the attack on Malay, at a devastating

rate. The attempt, the Admiral says, was justified.

Not especially cheerful is the fact that, though they are hard-pressed for manpower and materials, the Germans have been able to retool their plants and bring out four new airplanes. These are an ME-109-G with a liquid-cooled, 1,700-hp. engine; an improved model quickly following the original FW-190; a new bomber, Heinkel 177, intended to challenge our high-level bombing; and a Junkers 86-P. It is noteworthy that the new Messerschmitt has more armor, three cannon and two machine guns, but is not so fast as the original.

The air phases of the war seem to be going better for the United Nations than the surface operations. The score board does not show that we are yet winning the war at any point. But the President and a good many other people are pretty mad at second-string government executives who have been shouting that we are losing the war. Such statements are not only demoralizing, they are unsound. It is true that China and Russia and the British are still taking hard punishment. But when you consider that equipment is the means of warfare, and that the Allied arsenal, the United States, is getting stronger, you can hardly say our side is losing. On the other hand, Germany has passed the peak of war strength in manpower, and its productive power will get no better in the face of internal disruption. The Japanese live by the sea, and it is only a question of time till strong enemies all around the Nipponese archipelago will cut off their lifelines with a preponderance of warships and air power. Talk about losing the war will not help to condition the American war spirit, which is still too big around the paunch and too narrow in the chest and biceps.

Nazis May Hit West Again

If the Germans can manage to tie the Soviet Union up this winter and hold it with a limited force, the Luftwaffe will come back and make a supreme effort to penetrate Allied control of the air over the Channel and Western Europe. Safest guess, based on some expert opinion, is that the Nazis cannot hog-tie the Russians, and that even if the Luftwaffe comes back, it can punish England but cannot get the necessary control for an attempt at invasion.

Gen. Eaker started a hubbub when he said Germany could be destroyed from overhead. Eaker is an airman of great skill and imagination. He has had much experience with the press, and his statement was no slip of the tongue. He knew well enough what would be done with it. British air officers commented unofficially that they didn't think bombing alone would do the job. High authority in this country didn't say anything.

Air Power Held Underrated

It is plain, regardless of anybody's statements, that our program of tanks and munitions for an Army of 10,000,000 men is not now headed for pure air war. We can all argue, but strategy is in the hands of the men we have hired for the job. No one doubts they are doing what they believe to be right, and time alone can show whether they are or not.

Aviation appears to be the backbone of the war everywhere except in Russia. Plenty of airmen believe that aviation would give the decision there if either side had enough of it. The Army and the Navy both still regard air force an an auxiliary to ground and sea operations, while pro-air power men think they can show you, action by action, that surface operations are already subsidiary to aviation and the commanders can see it, or won't.

The Navy, which had been strongly criticized for sending Adm. John H. Towers, its able chief of aeronautics, to sea with a fancy title, and for not having any airmen on its general board, set its accusers back a bit by appointing seven old-time air captains to be aviation admirals.

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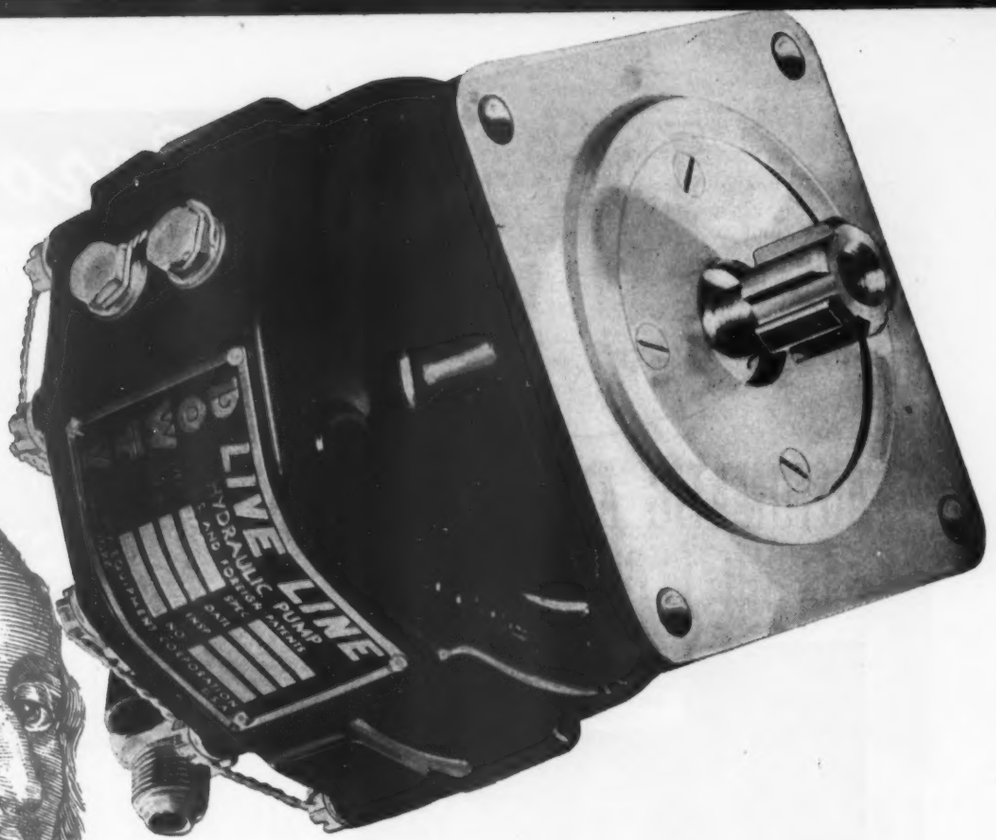

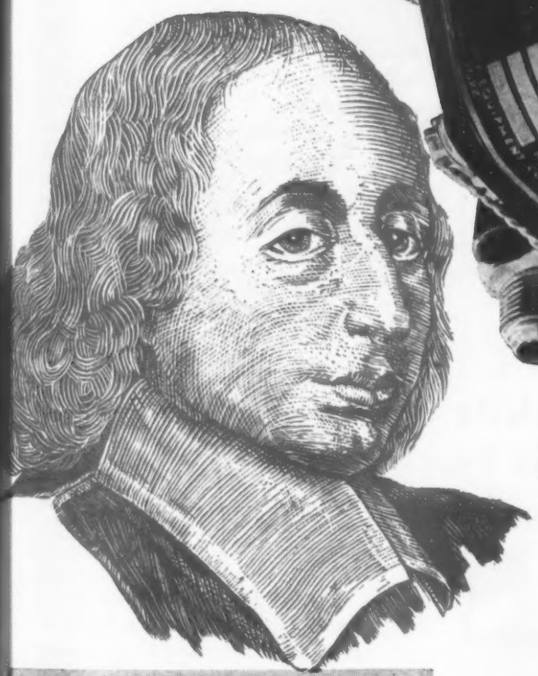

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A Variable Volume Oil Pump **(one which provides any desired quantity of fluid while running at a constant speed) was needed for the operation of hydraulically controlled accessories on aircraft.**

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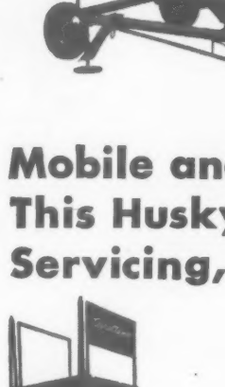
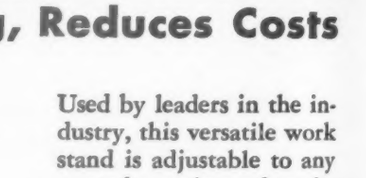


Used by leaders in the industry, this versatile work stand is adjustable to any part of any plane—does the work of several single-purpose stands. The platform extending over engine or wing enables workers to reach the hard-to-get-to places quickly and safely.

Easily adjusted to any height from 3' to 10' by hydraulic strut, equipped with mechanical safety pin; all-steel; supports 1500 pounds. The 4' x 11' base assures complete safety at all elevations.



Riding on 16" air wheels (or casters for hangar use) Aerostand can be towed *anywhere*—can take a trans-continental trip as easily as a trailer. Write for detailed information about this new servicing necessity.

*Trade Mark Reg. Patent applied for.

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Financing the Airlines

(*Continued from page* 221)

000,000? Most likely not. Its present stock outstanding aggregates less than $15,000,000. The market simply would not take an additional issue so huge, even if broken up in a few segments. The constant diluting of existing equities by additional stock offerings will constantly remain as a mitigating factor in such financing. More importantly, however, sound financial practice would counsel against all-inclusive equity issues for the industry.

The success of any future airline financing, regardless of its form, will be largely influenced by the economic regulation exercised by the Civil Aeronautics Board. The board is aware of its influence in this respect and has frequently noted that a sound regulatory policy is essential in order to attract necessary capital to the industry.

Interestingly enough, in its letter of May 11, 1942, replying to the resolution sponsored by Senator George, the CAB attempts to show that its policies have facilitated increasing interest and confidence of the investing public in air carrier stocks. To substantiate this contention, the board presents the Barron's group averages of the various industrials showing that for the period from Mar. 31, 1938, to Mar. 13, 1942, out of 35 classes of stock, the air transport group showed the largest relative gain with an increase of 114 percent during the period covered. (Note—these Barron's averages are the same series accompanying the articles in this department.) This is correct—as far as it goes. The board, however, neglects to mention that under date of Mar. 12, 1942, it issued its famed report ordering reduced and retroactive mail compensation for American. *This decision was mainly responsible for depressing air transport securities so that on Apr. 24, 1942, this group average declined to its lowest level since May 19, 1939. That demonstrates the power of the CAB in influencing trends.*

The CAB, in its report, further contends that the domestic air carriers have "been signally successful in raising capital for expansion." To prove this, a table is presented listing the various stock flotations representing 13 issues with an aggregate value of $16,590,254. Significantly, in this table, despite having the benefit of Forms 2780 filed with it and having complete access to the SEC records, the board omits one of the major financings of the period. This was the Pennsylvania-Central sale, on Nov. 25, 1941, of 75,000 shares of preferred stock having an offering price of $1,875,000—no inconsequential amount. Our Table II correctly presents *all* new stock offerings since Aug. 22, 1938, together with the added information of current market prices.

Up to its Mar. 12, 1942, decision on American, the CAB has unquestionably been a constructive force in assuring a strong base for the financial growth of the industry. The disturbing interlude following the Mar. 12 action was terminated when, on July 30, 1942, the board reversed itself on the recapture principle in setting mail rates for Pan American-Grace Airways. This reversal has had a major effect in sending the Barron's air transport average into new high ground for 1942, reaching 23.03 on Oct. 2, 1942.

A new danger to any future airline financing, however, is present in the board's recent philosophy establishing air mail rates so as to limit profits to a return of 10 percent on the investment. Such a policy cannot but help stifle initiative and serve as a retarding influence in the industry. Further, a definite ceiling on airline earnings would be established and some of the unwholesome attributes as top-heavy capital structures—which the CAB has tried to

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discourage—would actually be fostered.

Moreover, the public utilities and railroads present unending case histories as to the fallacy of a regulatory policy tying earnings to the return on invested capital.

The airlines are surfeited with cash now. The time will come, however, when the industry will have need to enter the capital markets in a substantial way and find itself at a disadvantage tied down with an established regulatory philosophy which is unsound in general and detrimental in particular to proper financing. The airlines should be awake to this jeopardy. Instead of complacency, an aggressive educational program is called for.

In the postwar period, there will undoubtedly be huge reservoirs of capital available for investment. It is up to the airlines to assure for themselves the best possible conditions to tap these sources of funds on the most favorable terms.

Air Cargo

(*Continued from page* 217)

further consideration although numerous intermediary charges that enter into it are being eliminated or deducted as result of the newer form of international transportation.

Technical improvements are increasing the efficiency of cargo planes through fuel economy and larger useful loads. Progress is being made in utilization of glider trains. All of these point to still more favorable effects in reducing the actual cost per ton-mile of goods transported by planes in world commerce.

In all countries, farsighted businessmen continually have been anxious to reduce time between purchase and sale of the goods they handle to permit faster turnover of capital, increase chances for profit and afford the benefits of attractive prices to their customers. Air cargo will help to achieve these goals and thereby, after the war, assist in restoring and improving the standards of living, in terms of goods, of people everywhere on the globe.

Tool Design

(*Continued from page* 129)

for each part and, at the same time, design department men note those parts which will be useful later as a source of information during design of the tools. As the breakdown of each surface is completed, it is given a final check by both the chief tool engineer and the chief process engineer. Copies of these records then go to the tool and jig design departments which immediately begin preparation of the drawings.

Template layout and tool manufacturing departments join in the next step, that of actually building the tools, jigs and templates which were called for by the breakdown. As soon as the equipment is built, it goes to the layout inspection department which, in every possible case, puts it through a test workout to double-check against inaccuracies.

An accurate cross-reference on all tools involved on any one job is maintained by the tool control department, which keeps a record of every piece from the time it is ordered out until it has passed inspection and reaches tool storage. This department also maintains a corps of expediters to keep checking on all tool orders placed with subcontractors.

Meanwhile, an intermediate step has been under way by one of the most effective functions performed by tool engineering. This is preparation of isometric drawings for use by assembly line operators. These drawings can be given much credit for the fact that Fleetwings' production has consistently exceeded prime contractors' requirements.

Since the majority of newcomers to aircraft assembly lines are untrained in reading blueprints, the graphic illustrations have proved a real boon. The conventional method of instructing new workers in assembly procedure, other than through use of blueprints, would be verbal instruction by the foreman or supervisor. This has proved unsatisfactory, however, for it results in a lack of uniformity since each individual may have a different slant on the over-all job. Even though the finished products might come out the same, there is a good chance it will not have been made in the most efficient way.

Use of isometric drawings eliminates all such guesswork. The graphic illustration portrays and explains the entire sequence of operations necessary in addition to itemizing all parts of their numbers which are required for the job.

Copies of the isometric drawings are also sent to all jig builders, production men, time study engineers and any others directly connected with the job at hand, since they enable everyone to have a clear-cut conception of the work.

Completion of the tool design does not mean the end of the job for the tool engineering department, however. Constant liaison is maintained with both manufacturing and engineering departments to seek new ideas and improvements which have been found essential to insure the smooth operation necessary to produce a swiftly increasing number of subassemblies for many of the nation's most important fighters and bombers.

FASTEST, FIGHTIN'EST PLANE *"the Havoc"*

The Douglas A-20 "Havoc" has been termed the most vicious, versatile airplane of the war. Also known in Britain as the "Boston," it is used as an attack bomber, torpedo bomber, night fighter, long range fighter, pursuit, interceptor, intruder. For three years the "Havoc" has been the scourge of the Axis on every front. And no enemy craft has yet matched it! So, America, your aircraft industry has out-designed and is now out-producing our enemies. Yankee ingenuity will win! Douglas Aircraft Company, Inc., Santa Monica, Calif.

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WAR TRANSPORTS: THE DC-3 AND C-47 "SKYTRAIN" • C-53 "SKYTROOPER" • C-54 "SKYMASTER"

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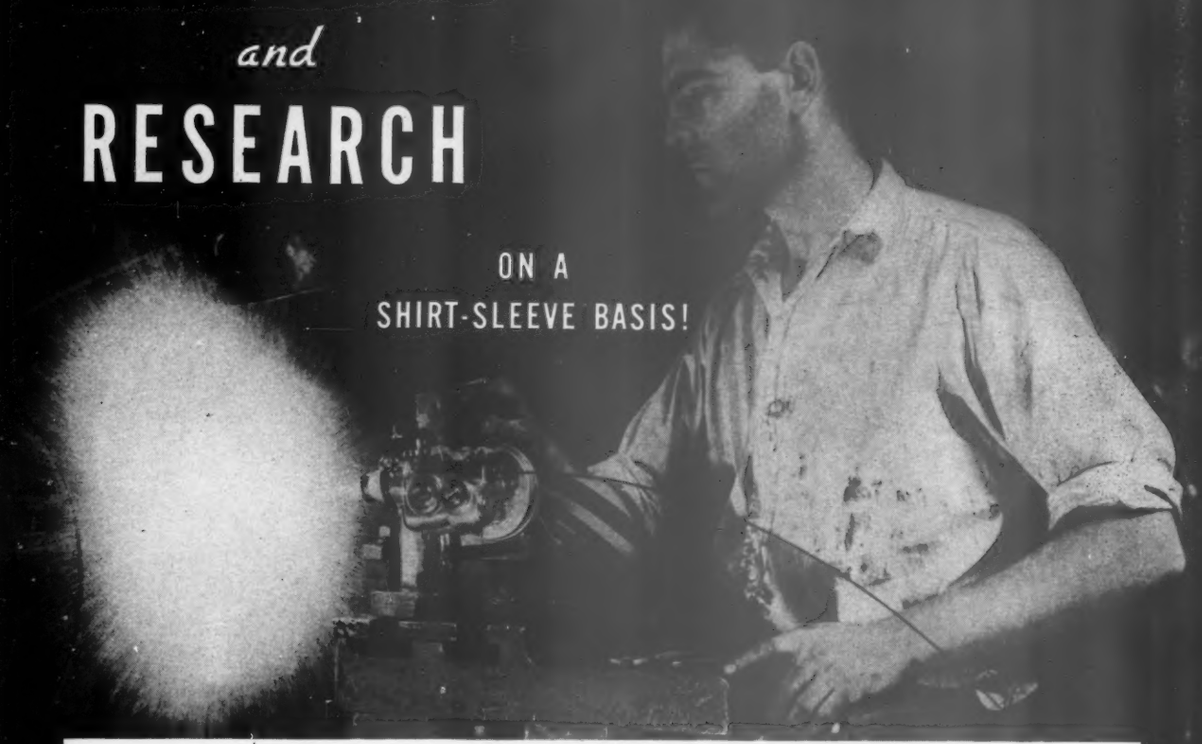

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Graphic Illustrators

(*Continued from page* 113)

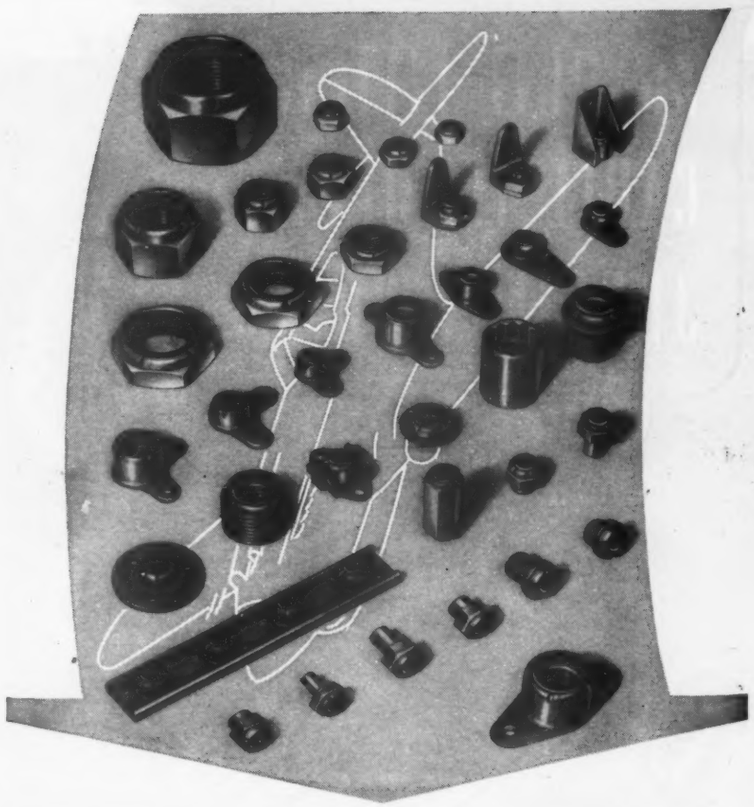
panies, used graphic illustrations for conveying clear pictures to assembly line men. But the sketches also find a multitude of other uses. For example, they are being reproduced in service, overhaul, and repair manuals, for it has been found that they can depict an infinitely greater amount of detail and clarity than is possible through the use of photos. This proves a real boon to the repair man who has never before seen the airplane on which he has been called to work. To him, the graphic illustration is as much of a help as it is to the assembly line operator. So far as is known, Fleetwings is the first aircraft maker which has adopted this practice of using three-dimensionals in manuals.

Second, the sketches are of considerable help in transmitting a vivid picture to subcontractors who, if they are typical emergency subcontractors, may be working on aircraft production for the first time. Still another use is found in company conferences. Photostatic reproductions of the three-dimensional drawings are bound compactly in books which are distributed to the conference members—a much more effective plan than is usually followed whereby huge, cumbersome blueprints are unfolded on the conference table. Use of the graphics requires no detailed explanation for clarity's sake.

A fourth, and perhaps even more vital application of graphic illustrations by Fleetwings is found in preliminary design. The most important benefit that stems from this plan is that the graphic illustration frequently calls to the designer's attention details that might be overlooked in mechanical drawings. The designer can, at this elementary stage, see clearly the need for changes. Thus hours of engineering time are saved, for if the changes are not made at this point considerable revision would doubtless be required later.

The graphic illustrator assigned to such work must be a veteran, one who has been around long enough to have a reasonable knowledge of aircraft structure, as well as an abundance of imagination. The bulk of the data given to the illustrator by the designer is via verbal descriptions and rough sketches. Almost no mechanical drawings are provided. It is obvious that here the artist, who has learned through experience to rely strongly upon his imagination, is well equipped to meet the requirements.

Today, a year after the graphic illustrations department was established, Fleetwings engineers and supervisors agree that the reverse approach to building the department has proved in reality to be the direct approach. The



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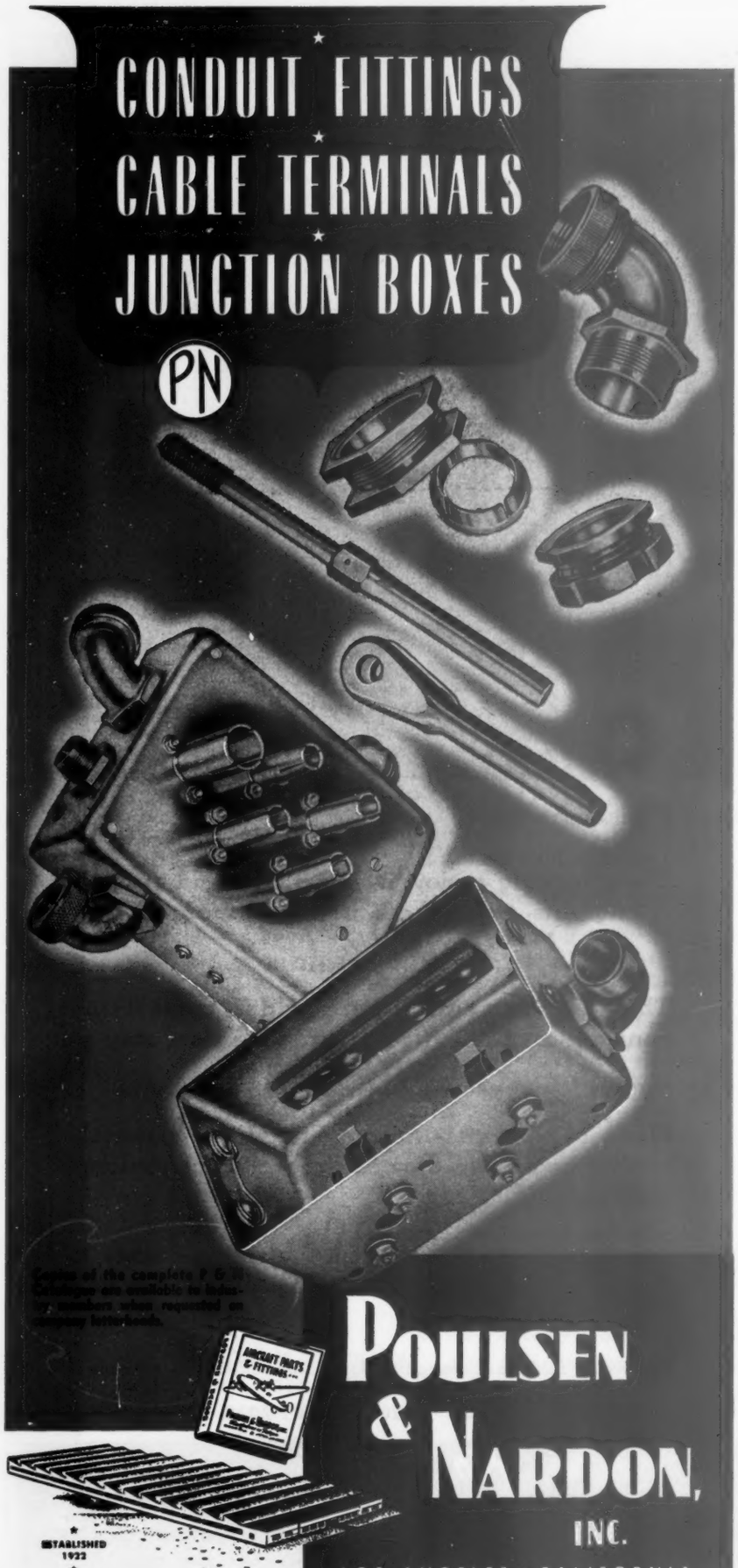
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high quality and speed of output of the group has more than shown this. And what is more significant—the demands on the division have multiplied many times over as its work has proved increasingly useful for a variety of jobs.

In addition to fulfilling, so adequately, the purpose for which it was primarily established, that of making graphic sketches, it has been found that the new department is also of great help on making posters, layouts for the company house organs, retouching photographs, and on many other jobs for the public relations department. This by-product is especially welcome because of the fact that such work would normally have to be farmed out to independent organizations. We feel that by working closely with these men, who are in their own right expert artists, we can get better results, and get them faster.

And just as the company is cashing in on this by-product, so are the artists themselves enjoying the opportunity of keeping their hands in the kind of work they know best. As Mr. Gonzales says: "These men are creative artists. They need the stimulus of creative assignments, otherwise they'd go stale."

Here's a sample of the kind of contribution the artists make. The *Fleetwings News* has been campaigning in behalf of proper segregation of scrap. Inspired by its stories, the graphic illustrators dramatized on a poster the effect of improper segregation and mixing of rubbish with metal. The poster fairly screamed: "Keep garbage out of the scrap containers. We can't fight with that stuff, Bud!" A low-flying bomber, its bomb bay open, dropped a melange of leftovers—apple cores, peach pits, orange and banana peels, lunch wrappings and half-eaten sandwiches. The posters were well received. The workers took the hint and a definite improvement was noted in the scrap metal boxes soon after.

Other projects which would have been next to impossible without the graphic illustrations department are now on the fire.

Water-based Airplanes

(*Continued from page* 123)

Lacking any sort of useful test data, those comments are only what I hope are reasonably intelligent estimates (which, in airplane design, are often more reliable than incomplete data). At any rate it can be said now that a hydrodynamic form of excellent aerodynamic shape is possible even if that shape does not conform to the usual, but deceptive, conception of the "perfect streamline."

The effect of water conditions on design is an important subject which, as

far as I know, has not been subjected to much effective analysis. You hear that a flying boat will "cope with a 4-ft. sea" or that it "took off in 6-ft. waves" —all of which means almost nothing. Every experienced boat pilot knows that boats have often taken off and landed in apparently impossible conditions and yet got into trouble or even cracked up under "easy" conditions.

This is a big subject for which we have space only for a general outline.

The study of the effect of rough water on waterplane action comes under three main headings:

1. Piloting technique, which is outside the scope of these notes beyond the observation that it is today too large a factor in reliable waterplane operation,

2. Stability and control of the ship, which can be a different matter under wave action from its flat water characteristics,

3. The actual forces of water contact, separated very distinctly into their vertical and horizontal components.

But first of all, what is "rough water"? To express this in terms of wave *height* alone means nothing useful. A high but short chop, as with wind against current, may look very fearsome, yet it may have so little shear strength as to have very small effect on the action of the ship in spite of impressive clouds of spray. A low but long swell may have a deceptive appearance of calm, yet have such great shear strength as to force the ship into pitching and heaving motions which hinder or destroy longitudinal control at critical speeds.

There is, of course, no dividing line between these conditions; there are intermediate conditions, and there are combined conditions such as when a short chop is superimposed upon a long swell. (There are also, of course, complications such as cross-swells which might be described as "advanced study" subject.) However, one point emerges at the start, namely, that wave *length* is at least as important a factor as wave height. The figure for wave *height* as a criterion of water conditions is used today because, like time for takeoff, it is easier to measure even if it doesn't mean much.

Once we begin to consider wave *length*, the study of rough water effects begins to take some sort of shape. For example, it is usually considered that the larger the flying boat the better it can tackle rough water—obviously, because (if we still think in terms of wave *height*) the waves are relatively smaller. Yet practical experience does not always confirm this. Many factors such as wing and power loading and wind speeds intervene, but in general a study will show that one of the principal requirements of hyrodynamic seaworthiness is the

(*Turn to page* 286)

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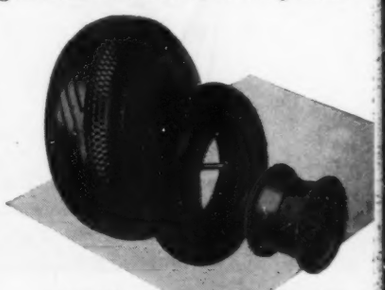

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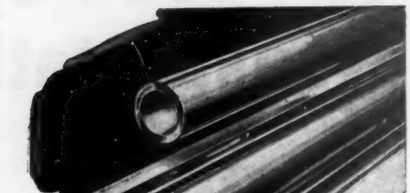

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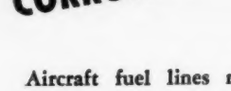

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ability of the ship to adapt itself inherently, or be adapted by applied force, to resist excessive pitching and heaving oscillations caused directly by, or resulting indirectly from, *vertical* water forces, and thus to follow a reasonably modulated path through the waves. Such vertical forces will be local and brief in short waves, or general and prolonged in long waves, and the problem is less one of the actual length of the ship than one of the relations between ship-length and wave-length.

The result of the horizontal component of water forces from waves or swell is almost exclusively confined to retarding acceleration on takeoff. (It is also useful in providing a brake, if sometimes a violent one, against landing run.) The direction in which these forces act along the hull (which is mainly a matter of trim) is also an important factor.

These considerations must be taken along with previous remarks on beam loading, deadrise, steps, afterbodies and trim. The study is a complicated but by no means a hopeless business. Let us take just one example: we now employ deadrise as a means of shock absorption against such action as pounding in waves, and the greater shocks we expect the more deadrise we use. Yet it is well known that the greater the deadrise the greater is the trim angle required for best hydroplaning, and therefore the steeper is the face presented to the oncoming wave. Thus deadrise not only defeats its own shock-absorbing object; it has added to the required beam and hence to the amount of "new" water to be suddenly displaced. This is just one of the factors which contribute to making a rough sea takeoff the hectic affair of haphazard punishment which it now is.

Nobody will suggest that all rough sea takeoffs can be made nice smooth affairs. What I do suggest is that, for a given sea condition, the hydroplaning run can be made a lot steadier than it is or, alternatively, that for a given beating a considerably rougher sea could be coped with.

There will be sea conditions when takeoffs will not be a practical possibility. But there will be hardly any conditions in which a properly designed waterplane will be unable safely to get down and stay afloat, and thus to take off later.

Water Handling

The difficulties of handling water-based aircraft on the surface comprise a large subject which cannot usefully be discussed if one thinks only in terms of what has been done up to now. Anyone who watches the amazingly clumsy processes of attaching or removing beaching gears, or such work as attending to engines at moorings, may possibly be excused for supposing that such difficulties are an inherent objection and handicap to the use of waterplanes. They are not.

It must be remembered that probably several thousand dollars have been spent on landplane bases for every dollar that has gone into seaplane bases. A primitive ramp, a few moorings and a motorboat is all you got for a "seaplane base" 20 years ago and, in many cases, it is all you get today.

Some people may remember the efforts of George Post, in the days of the great aviation and airport boom, to get seaplane bases laid down at which special types of docks were to be installed for rapid and easy seaplane handling. A very few were put down here and there. Primitive as they were, these docks pointed the way to what could be done to make the handling of water aircraft a vastly different matter from what it now is. Yet I well remember the immense efforts Post had to make to get even a few hundred dollars applied to seaplane bases by people who were spending millions on land airports.

At a small fraction of the cost of building and maintaining a land airport an equivalent water airport could be prepared in which the waterplane could be handled as easily as landplanes are handled. And while your main water air bases were so equipped, your waterplanes could still use unprepared bases in a manner which landplanes can never hope to do.

The reason why no such bases exist goes right back to our original problem: that of the low performance of flying boats. In both commercial and military fields the flying boat has nearly always been used over routes or areas where small volume of flying, poor terrestial conditions, or uncertain political or military factors have made the establishment of fixed landplane bases either undesirable or too difficult.

But when conditions have become suited to the establishment of such landplane bases the tendency has always been to replace the flying boat by the higher performance landplane. So the flying boat and the unprepared base have become inseparably associated, and are treated accordingly in both design and operation.

When this performance problem is dealt with it will be found that, dollar for dollar, the waterplane will be at least as easy to handle as the landplane until, when we get to *very* large sizes, the landplane will not be possible to handle at all.

Summary and Conclusions

Even in the few months since this series was started events have placed

new and powerful emphasis on my original premise, namely, that present and future military needs demand that we shall, as we can, produce water-based aircraft of as high performance as any other form of aircraft.

In that period, during which air-sea operations have reached entirely unexpected dimensions, hundreds of American and Allied airplanes and crews have been lost in the Pacific, the Atlantic, the North Sea, the English Channel, the Mediterranean. Some of these were shot up and would have been destroyed anyway. But a very substantial proportion were those which, through mechanical damage or failure, or through exhaustion of fuel, were forced to descend into an element for which their only provision was a rubber dinghy—if they could get it working. Pursuit ships have sunk like stones. Bombers have floated briefly. Others, with miles of water within reach, have crashed on unprepared land because they could not reach their prepared runways or failed to negotiate them in murk or darkness.

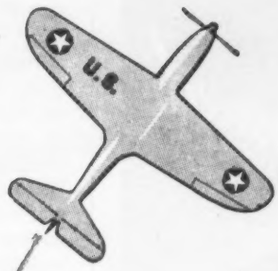
Bombing operations over long sea stretches, and the important surface operations connected with them, have been immeasurably restricted in efficiency because the bombers have had to carry, instead of more bombs, a big enough fuel load to fly from their prepared ground bases *and get back* to prepared ground. Or they had to fly off a carrier with the chance of finding it sunk or smashed on their return. The raids of Gen. Royce on the Philippines and Gen. Doolittle on Tokio were magnificent affairs; but they were done *only once* because landplanes had to be used for which bases were too scarce.

It appears that sometimes convoys are given emergency protection by a landplane fighter which is catapulted from a ship, does one job and is then lost or ruined by having to drop into the water —about as pathetic an airplane operation as one can imagine.

Now that our battleships, cruisers, carriers and transports can no longer approach enemy air bases without the present terrific risk—and future certainty—of being sunk, we are beginning to hear that the protection of such surface ships as we have to use and our future offensive operations must depend on "long-range, land based aircraft."

If that is so, then America gives up the seas and oceans. These are to become merely vast deserts, to cross which most of our military load must give way to two-way fuel loads, and in which disabled aircraft and their crews must be lost.

A country which cannot use the seas cannot control them, and an air force which must always return to its own



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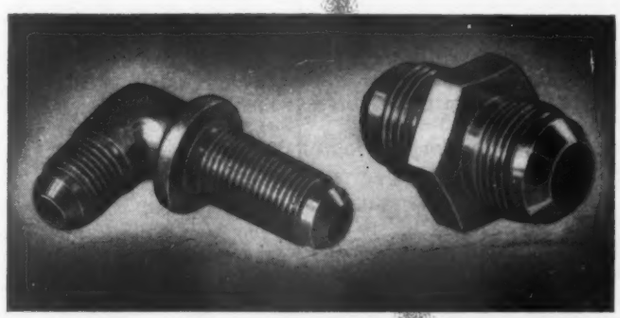

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strips of land is unlikely to control more than its own border strips of water.

We have now arrived at a stage when the future development and employment of water-based aircraft is less a technical problem than a psychological one. We have become so completely landplane-minded that low performance in waterplanes (and hence their relative uselessness) is taken completely for granted. So any technical argument on the point not only doesn't get to first base—it doesn't go to bat.

You may think this statement is contradicted by a recent outbreak in favor of huge cargo flying boats. But please note the "huge," which usually means, in aircraft, something about twice as big as anything existing. It is a fact beyond dispute that, in any size in which both landplane and flying boat have both been built, the landplane has the better performance—usually a much better performance. The flying boat has so far held its own only while airport and landing gear technicalities have lagged for that particular increase in size. Hence whenever some outfit has wanted to build an airplane which would perform miracles of carrying power, it has nearly always promoted a "huge flying boat." You have only to remember such names as Caproni, Marcel Besson, Penhoët Latécoère, and Dornier with his DoX. These huge boats never came to anything; they were never likely to, in spite of being designed, in some cases, by quite competent engineering staffs. All this arises from the old, established belief that, if you only build a flying boat big enough, you will get efficiency from it—whereas the nearest actual fact is that, if you only build a flying boat big enough, you will have no landplane big enough to compare with it and demonstrate its inefficiency.

If the actual factors are analyzed, as I have tried to do in an elementary form in these notes, it is seen that those factors which principally cause flying boat inefficiency have little or nothing to do with size; they are inherent in the "modern" flying boat formula of design, and they apply on any scale. This, indeed, is obvious from progressive results. So if you build a huge enough flying boat, the best you can say for it is that there probably will be no equivalent landplane to compete. *But, on present lines, it will still be the same inefficient airplane as its smaller predecessors.*

So these new plans for huge flying boats are not going to help waterplane progress. They are merely telling an old story in its latest and most expensive form. (Incidentally, several people have asked: what are the advantages of the twin-hull arrangement? The answer is: none at all, though it has a number of disadvantages.)

We are not going to get efficiency in "huge" flying boats until we can get it in any size. So it is much worse than useless to squander money on grandoise schemes for mammoth craft when a fraction of that money would establish principles of efficiency on a smaller scale.

To summarize very briefly the technical situation: The poor performance of water-based aircraft is not, as is too often supposed, a matter of the air drag of steps, chines, wing floats and other such hydro-details; it is basically the result of the excessive weight and drag of the vast bulk of the hull. When this problem is dealt with, those other details will either vanish or become of negligible importance, since they are mostly the direct or indirect result of trying to get proper trim, stability, shock absorption, and reduced water drag with a set of dimensions which are too big for the job. These dimensions are too big because they are based entirely on the volume required to support the airplane at rest on the water.

The design and performance of the modern landplane is based largely on the retraction of its surface support; there is no reason whatever why parallel results cannot be achieved for the waterplane at a comparatively low cost in weight.

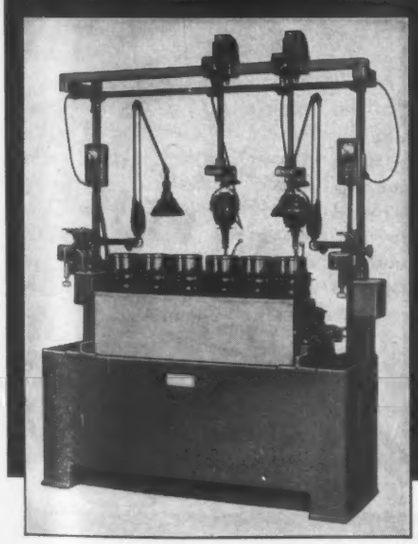
It has, incidentally, been suggested that, for these military cargo planes, the huge space of a flying boat hull will be necessary for accommodating all that cargo. It will not. Such cargo will inevitably be of high average density so that the fuselage volume of a normal landplane which could carry the *load* would also, in the vast majority of cases, also provide the required *space;* there is therefore no sound reason why a boat should have more relative space.

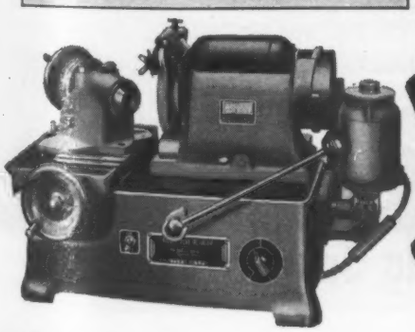
The problem of producing waterplanes equal in performance to landplanes is principally one of tackling the subject anew on its own merits instead of trying to patch up an ancient formula which, on its own showing, cannot obtain satisfactory results. As a problem it is neither too easy nor too difficult.

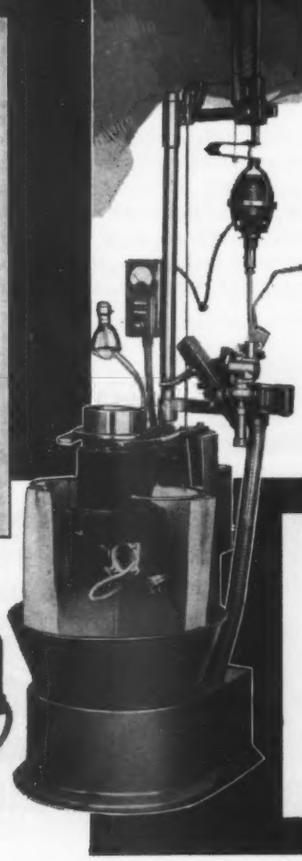
In smaller sizes, such as the single-seat fighter, the problem is somewhat more difficult than in the larger sizes, partly because of practical operating factors such as absolute freeboard. But in medium and large sizes such troubles diminish and vanish. So we can get waterplanes which, as airplanes, will be the equivalent of any other airplanes, and which can efficiently use the water with gear no heavier, and probably much lighter, than land gear.

Somebody will get those results sooner or later. The sooner *we* start to try the further ahead we shall be.

The Instruments He Can't See are Important too!







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YOU can help meet your tool shortage by using this new service to keep all your RIDGID Pipe Tools on the job. Simply collect all your old worn RIDGID Wrench Jaws and Chaser Dies and turn them over to your Supply House with order for this Reconditioning Service. Your Jobber ships them to us with parts from other customers, to save shipping expense, for we allow one-way freight to Jobber on 100 pound lots or more. Remember: *only RIDGID trade-marked parts accepted for this service.* No priorities needed. Service is prompt. • Parts you send us are carefully inspected, to make sure they're worth reconditioning. We reserve the right to reject them if they can't be made as good as new.

Your RIDGID dies Factory Reconditioned **44¢** PER SET OF 4 Plus small shipping charge

Quick Reconditioning of RIDGID Chaser Dies

Threader dies are accurately re-ground to original specifications. They are then inspected and tested and sent back to you under RIDGID new parts guarantee.

Dies for RIDGID No. 65R Series

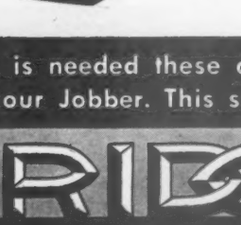
Dies for RIDGID No. 1R Series

Dies for RIDGID No. OOR, OR, 11R and 3-way Series

Quick Reconditioning of Your RIDGID Wrench Jaws

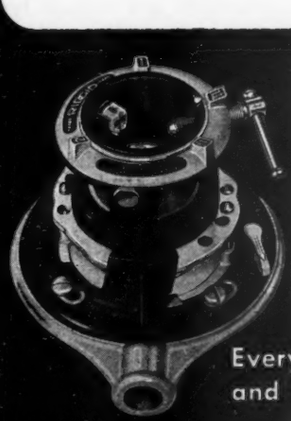
Both hook and heel jaws are scientifically annealed in our automatic electric furnaces, same as new jaws. . . . They are recut in the same machines and by exactly the same methods as used for new jaws. . . . Jaws are then re-hardened like new. . . . After final inspection, they are returned to you under regular RIDGID new parts guarantee of satisfaction.

Your RIDGID wrench jaws Factory Reconditioned **1/2 PRICE** OF NEW PARTS Plus small shipping charge



RIDGID Wrench Heeljaw with pin

RIDGID Wrench Hookjaw



Every tool is needed these critical days. Gather up your worn parts now and call your Jobber. This service is available only in the United States.

All RIDGID Pipe Tools are sold through Supply Houses

★ RIDGID ★

THE RIDGE TOOL COMPANY ELYRIA, OHIO, U.S.A.

Pipe Wrenches, Cutters, Threaders, Vises

Work-Saver Tools for America's Big Job in 1942

Design Details, BMW-801A

(*Continued from page* 229)

cial oil cooler through which cooling air is forced between the cooling gills until it exits thru a controllable peripheral slot near the cowling nose.

Between cylinders there is an annular ring forming a center tracing for the cowl and also acting as a collector ring for cooling air for the rear cylinder leads. Air from the front fan is forced into the ring from which it passes through "scoop-ducts" which are riveted to the ring and which guide the air direct to the cylinder head fins. Front and rear cylinders have these "scoop-ducts."

Around the cylinder barrels and sides of the cylinder heads are elaborately shaped one-piece cooling baffles, the throats of which lead into the center annular collector ring. At the front of each of these skirt baffles are riveted small fin-shaped deflector baffles for directing the flow air to the rear of the engine.

The aluminum alloy supercharger delivery casing is bolted at the rear of the crankcase, in turn having a heavily ribbed magnesium alloy intake case bolted to it. Bolts fixing the two casings together pass through into the crankcase and secure the whole assembly.

The supercharger has a two-speed gear train—the drive to both gear ratios being made through a main drive gear with a hydraulic-operated clutch mechanism. The supercharger impeller is a little more than 13 in. diameter and has 24 blades. It is machined from an aluminum forging. Alternate blades have a curl-over center portion to direct the air to the blade tips from the center intake. The rear half of the supercharger casing is a good example of fine German magnesium casting technique. This cover carries flanged bosses for the generator, vacuum pump, gasoline delivery pump and the elaborate 14-cylinder injection pump.

The Gasoline Injection System

This injection pump is interesting in that it is the first multi-plunger high pressure pump built for production in radial form. The pump is made by Friedrick Deckel and, typical of that firm's products, is real precision engineering.

The 14 radially disposed plungers and sleeves are moved back and forth by a cam ring with three cams driven from the supercharger drive at 1/6 engine speed. Each plunger is moved by a spring loaded roller cam follower which is in constant running contact with the base of the cam ring.

Each pump plunger-sleeve carries a gear ring at its lower end and in slots

They're Coming in... Lights Up!
Roaring planes returning to outlying and secret air bases far from electric power lines — inky blackness below. Then compact, portable units, powered with flash-starting Briggs & Stratton gasoline motors, swing into action and floodlights gleam. Ample light for a safe landing and for speedy service. This is but one of scores of jobs that more than a million and a half Briggs & Stratton motors are doing daily — with our armed forces everywhere, as well as on farms, in homes and for industry.
For the duration, in ever increasing quantities, Briggs & Stratton 4-cycle, air-cooled motors are being produced only for war and approved civilian uses.
To assist in the conservation of critical materials, owners and operators of Briggs & Stratton motors are urged to give them more frequent inspection and care than normal, to avoid unnecessary need for repair parts. If additional service or parts are needed, go to your nearest dealer or an Authorized Service Station.
BRIGGS & STRATTON CORP.
Milwaukee Wis., U. S. A.
4 CYCLE
BRIGGS & STRATTON
GASOLINE MOTORS

THEY'LL GET THERE *First*
- - - WITH THE *Most!*

GETTING there "fustest with the mostest" is an axiom as important in the warfare of production as on the battle front. That's why, in hundreds of America's highly geared war plants, you'll find P&H Zip-Lifts handling materials beside machine tools, along production lines, in warehouses, loading zones, etc. They're saving time, manpower — helping get America there *first* with the *most!*

CAPACITIES
250, 500, 1,000 and 2,000 lbs.

IT'S a small, *wire rope* electric hoist with full magnetic push button control; with lifting capacities of 250, 500, 1,000 and 2,000 pounds. Bolt, hook or trolley mountings are interchangeable. To aid the war effort, qualified defense plants can depend upon P&H's honest delivery dates.

General Offices: 4593 West National Avenue, Milwaukee, Wisconsin

HARNISCHFEGER
CORPORATION
HOISTS · WELDING ELECTRODES · MOTORS · P&H · EXCAVATORS · ELECTRIC CRANES · ARC WELDERS

in this gear—with its flat sided wings—slides the plunger. Rotation of the gear rotates the plunger altering the cut-off angle of the quantity control which is helically cut into the head of the plunger. The whole set-up is similar in design to the familiar Bosch diesel pump.

The quantity control mechanism for the 14 plungers is ingenious. As stated, each plunger sleeve has a gear at the inner end; this gear and other plunger gears are inter-meshed by a circular gear ring which rotates each plunger. Control to the pilot is made by a short shaft geared at one end and meshing with the top plunger sleeve gear.

Gasoline is fed to the injection pump plungers through a circumferential core in the pump casing from the supply pump located close-by on the rear supercharger case. Provision is made for any air accumulation in the liquid to be diverted through a series of cored passages to an air collector located in the injection pump body within the circumference of the ring of plungers.

Plunger design closely follows standard diesel practice. Each plunger head is helically cut and grooved to provide a suitable angle face to the intake and cut-off ports in the sleeve to allow for varying throttle condition Every pumping element is provided with a sliding-type non-return valve on the delivery side. This is in no way similar to the famous Bosch-Atlas valve but no doubt fulfills the same purpose as far as is necessary on a lower pressure injection system.

The injector which is located between the valves in the cylinder head is of interesting design. In contrast to Mercedes-Benze design, the injector orifice is of the open type and the head of the needle closely resembles the Bosch pintle type injector. Diameter of the pintle injector needle is 0.050 in.

Directly inside the injector body at the injection end the needle diameter is increased and a three-start sharp-cut thread is used both as a fuel passage and also to impart a swirling action to the gasoline when entering the cylinder. The remainder of the injector design follows standard practice. A small circular filter is incorporated within the body of the screw-in gasoline inlet plug located at the top of the injector.

Lubrication System

The lubrication system in the BMW motor is interesting in view of its complexity and thoroughness. No fewer than six pumps are used—two pressure and four scavenging pumps.

Reference to the accompanying diagram showing this lubricating system lay-out readily shows the oil flow.

The pump *A* in the drawing delivers

THE MARQUETTE ALL-WEATHER WINDSHIELD WIPER

Engineered FOR ALL TYPES OF AIRCRAFT

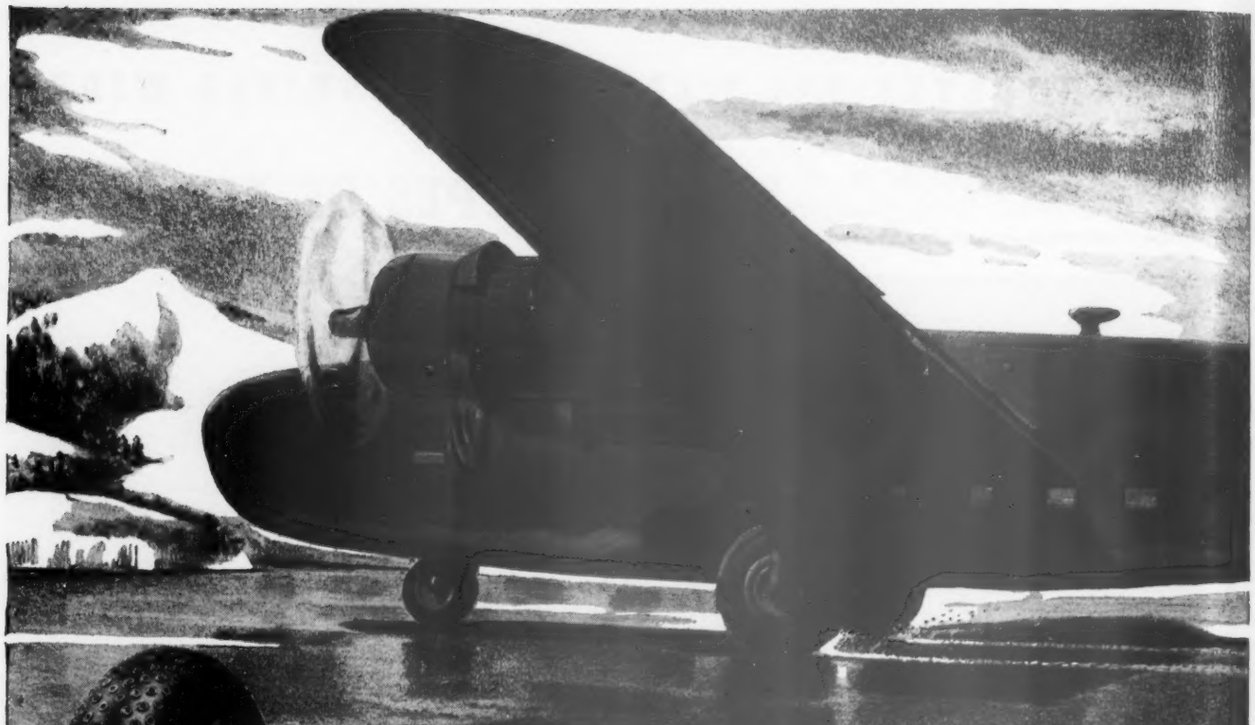
OUR FIGHT FOR FREEDOM GOES ON...

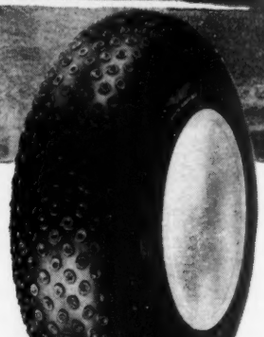
in good weather, in bad weather. Our All-Weather Windshield Wiper provides clear sight for all aircraft. Rain and Snow will not retard the fight!

The Marquette

METAL PRODUCTS COMPANY

1145 GALEWOOD DRIVE • CLEVELAND, OHIO





STOPS 'EM ON ICE

One of the slipperiest problems up North was the landing of 25-ton planes on glare ice or hard packed snow without an expensive crack-up. The ice formed a perfect lubricant for rubber tires regardless of the tread design—turned the tires into sled-runners, sent the plane into the next county.

This problem that had to be solved was put up to United States Rubber Company engineers.

Result: a tire that has turned ice fields into landing fields—the U.S. Royal "Ice Grip Tread" covered with rubber buttons, the outside rows of which have crimped steel "bottle caps" imbedded in them. These sharp metal edges bite into the ice and snow when the brakes are applied and, it is reported, stop the plane as quickly on ice as ordinary tires do on a dry concrete runway.

Do you have a tough airplane tire problem? There is a "U.S." Airplane Tire engineer near you ready to help. Use him!

ROYAL AIRPLANE TIRES

ONLY "U. S." HAS THESE EXTRAS

1 **TEMPERED RUBBER TREAD**—A tougher, scuff- and heat-resistant tread compound for airplane tires.

2 **SAFETY BONDED RAYON CORD** — A lighter, more resilient, airplane tire material with tremendous impact resistance and stamina at high temperatures.

3 **FIELD AIRPLANE TIRE SERVICE**—A force of "U. S." field engineers in every part of the country is promptly available for engineering and technical help on tire and undercarriage problems.

4 **"U. S." ICE GRIP TREAD**—A tread of revolutionary design and performance for snow- and ice-covered landing surfaces.

5 **STATIC GROUND CONSTRUCTION** — Conductive rubber construction grounds static electrical charges upon contact with the ground. This safety feature is available in all U. S. Royal Smooth Contour and auxiliary wheel tires.

RAYON IN EVERY "U. S." TIRE — A "U. S." TIRE FOR EVERY PLANE

UNITED STATES RUBBER COMPANY

AIRPLANE TIRE DEPARTMENT • 6600 E. JEFFERSON AVE. • DETROIT, MICHIGAN

at 175 lb. psi, and a special check valve is provided between the outlet and the inlet side of the pump to prevent excessive build-up in the aircooling system. The pump *B* delivers through a rotating vane type filter driven by gearing from the pump. Pumps *A* and *B* are coupled on the delivery side and the common outlet is fitted with an automatic pressure control valve which maintains a constant oil delivery when hot at a little in excess of 100 psi. This valve also serves to provide excessive oil pressure when the motor is cold.

There is a lead-off through a pressure-reducing valve to the valve gearing which is lubricated at much lower pressure. The valve gear is scavenged by the pump *B*.

Drainage and scavenging from the whole of the front of the engine including the fan drive gear, propeller reduction gear and front cam epicyclic gearing are scavenged by the two pumps *E* and *F*. Drainage from the lower half center crankcase and the accessory drives located on the rear supercharger casing are all drained and scavenged through pump *C*.

Very thorough arrangements have been made for de-icing and heating, all of which are taken from the exhaust system. In the Dornier 217E the effectiveness of this heating set-up is shown by a plate on the instrument panel giving the pilot instructions as to what to do when the cabin and other parts get too hot. Air is led across the finned exhaust pipes to such places as the wing leading edges, the front bomb compartment and the cabin. A special multi-drilled tube runs round the transparent cockpit cover through which hot air is distributed over the wind shield.

Specifications are as follows:

International power rating—1,460 bhp. @ 2,400 rpm. @ 16,250 ft. @ 3.6 psi. manifold pressure.

Maximum cruising power (continuous)—1,280 bhp. @ 2,300 rpm. @ 18,500 ft. @ 2.2 psi. manifold pressure.

Maximum power (emergency)—1,585 bhp. @ 2,550 rpm. @ 15,750 ft. @ 4.5 psi. manifold pressure.

Normal cruise (economy)—1,150 bhp. @ 2,100 rpm. @ 19,500 ft. @ psi. manifold pressure.

Maximum power for takeoff for 3 min.—1,580 bhp. @ 2,700 rpm. @ 4.7 psi. manifold pressure.

Bore—6.15 in.

Stroke—6.15 in.

Volume—2,520 cu.in.

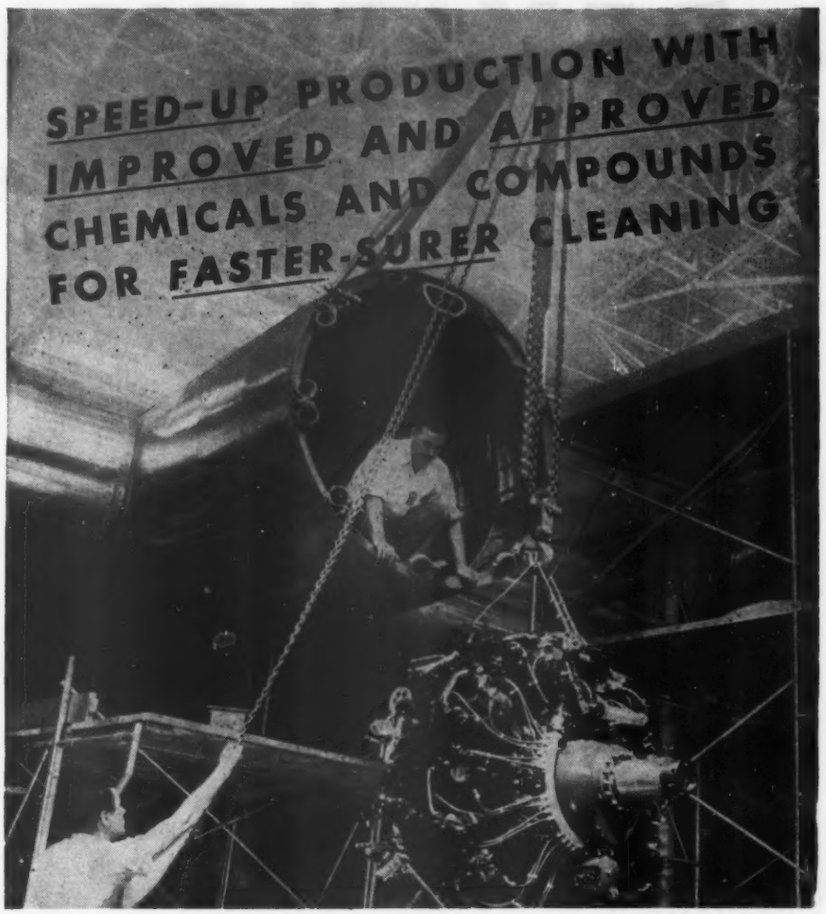
Overall diameter of engine—50 in.

Overall diameter of cowling—52 in.

Length—58 in.

Propeller reduction gear—0.54 x crankshaft speed.

(*Turn to page* 296)



Don't Risk A Break In Schedules Due To Obsolete Cleaning Methods . . . Be Safe and Learn About These New *Specialized* Cleaners For Your Production!

ANODEX *Original* REVERSE CURRENT PROCESS AND COMPOUNDS proven by many to be the fastest, safest and surest way to get ferrous metals metallurgically and chemically clean prior to finishing or plating . . . *Especially recommended for steel parts of airplane engines.*

METEX *specially mixed* AERO COMPOUNDS prepared for the faster, more exacting requirements of the war industry and compounded especially for the cleaning of Aluminum and Alloys . . . Proven to be faster and better for aluminum pistons!

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SALES AND SERVICE FROM COAST TO COAST

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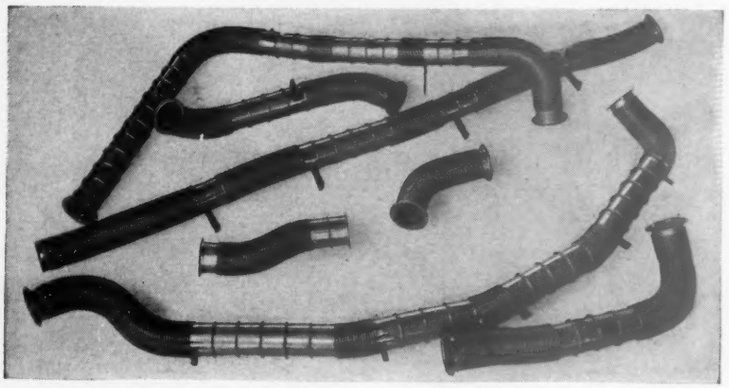
REX-FLEX

Stainless Steel Flexible Tubing

SIMPLIFIES AIRCRAFT ASSEMBLY . . .
MAKES TOP PERFORMANCE DOUBLY SURE



Units Shown are Typical Vari-formed Assemblies

Rex-Flex Stainless Steel Flexible Tubing combines the high fatigue value and the heat-and-corrosion-resistant qualities of stainless steel with extreme light weight and flexibility. Rex-Flex is bendable in multiple planes, available in long lengths, and can be "snaked" into place in cramped installations, eliminating joints. Simplifies and speeds up installation of air ducts, exhaust connections, blast tubes, heater ducts, power plant accessory parts.

Rex-Flex Stainless Steel Flexible Tubing is available in five wall-forms, all of which can be combined in a single one-piece length, with straight walls and corrugated sections at desired intervals. Sizes 5/16" I.D. to 5" I.D. inclusive. Made of 18-8 (Austenitic) Stainless Steel. Fittings are attached to tube ends by circular resistance seam welding. No flux, no flame, no quenching—producing absolutely tight, homogeneous assemblies.

REX-FLEX is a production item originated to meet certain requirements of industry at peace. Fortunately REX-FLEX, as well as our older established Flexible Metal Hose products, have proved vitally important to our country at war. REX-FLEX is offered as a typical result of the engineering initiative and productive resource of this company. We welcome further tests of our ability to match our services to your needs.

CHICAGO METAL HOSE CORPORATION

General Offices: MAYWOOD, ILLINOIS
Factories: Maywood and Elgin, Ill.

Supercharger—twin speed.
low ratio—5.07 x crankshaft speed.
high ratio—7.46 x crankshaft speed.
Forward cooling fan—1.72 x crankshaft speed.
Three blade constant speed propeller—13 ft. diameter.
Spinner diameter—19½ in.

(For details on the BMW-801D engine installation in the Focke-Wulf 190, see AVIATION, October, 1942, page 233.)

Cooperation for Victory

(*Continued from page* 95)

Curtiss-Wright Corporation, by cooperation with subcontractors, has cut in two the time required to instruct manufacturers unaccustomed to aircraft work in the intricacies of their new trade. Material wholly and usually secretly developed by Curtiss-Wright has been turned over to subcontracting firms to help them speed production of essential war goods. Men sent by concerns newly working with Curtiss-Wright are given exhaustive training in aircraft production through a two- to five-week course. Instructors from the front office join those in coveralls from the shops in teaching trainees every detail which Curtiss-Wright has only learned through hard-won experience. But when the men at school return to their respective companies to put to use what Curtiss has taught them, results are immediately apparent in the greatly swelled total of warplanes reaching the United Nations.

It is apparent even to the most skeptical observer that the American aircraft industry is teaching its subcontractors and licensees so well and cooperating with them so completely that the newcomers to the field of aviation will be able to compete with old established aircraft concerns after the war. But it is also apparent that the aircraft industry is not worrying about post-war conditions until after the war is won.

United Aircraft Corporation, including Pratt & Whitney, Hamilton Standard Propellers and Vought-Sikorsky, is also cooperating fully with subcontractors to teach them everything won by experience. At Pratt & Whitney, as an example, employees of licensees have spent a total of 37,250 man-days or 102 man-years to learn how to build engines when they return to their own companies. At Hamilton, more than 360 employees of licensees, and other companies, have spent a total of 9,640 man-days in training and study. At Vought-Sikorsky, 24 engineers from manufacturers and subcontractors have taken a six-week training course and plans for additional courses made.

(*Turn to page* 299)

Walter Snow Fighters

HANDLE *ALL* AIRPORT SNOW CONDITIONS!

(Deep Drifts . . . Heavy Snows . . . Light Snows . . . Icy Formations)

No Snow can Stop THIS Combination!

Shown herewith, and in action above, is the 8-ton, 175 h.p. model FGBS Walter Snow Fighter, with Offset V-Plow and Roto Levelling Wing, powered with 175 h.p. auxiliary engine. This unit clears 16 foot widths, at average speeds of about 10 m.p.h. The great plow "pours" the snow, while the Roto Wing levels and disperse snow banks. Roto Wing adjustable to any depth of snow.

Official tests* prove WALTER SNOW FIGHTERS clear greater areas-*faster*

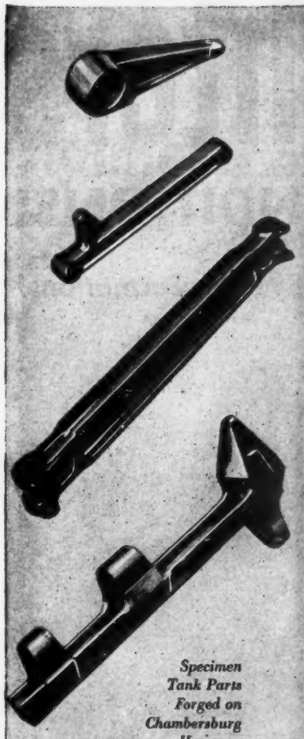
AIRPORT snow clearing methods "as usual" will not suffice in this winter of war emergency. You need the most modern, powerful, specially designed equipment available . . . WALTER SNOW FIGHTERS . . . to keep runways open and safe for continuous air traffic.

The exclusive Walter 4-Point Positive Drive gives Walter Snow Fighters their great power and traction to blast through deep drifts and to pull steadily on icy surfaces. To meet all conditions, these units are available with specially designed offset V-Plows, Speed Plows and Levelling Wings for deep snows; with pressure center scrapers and sand or chemical sprayers for hard-packed or icy formations.

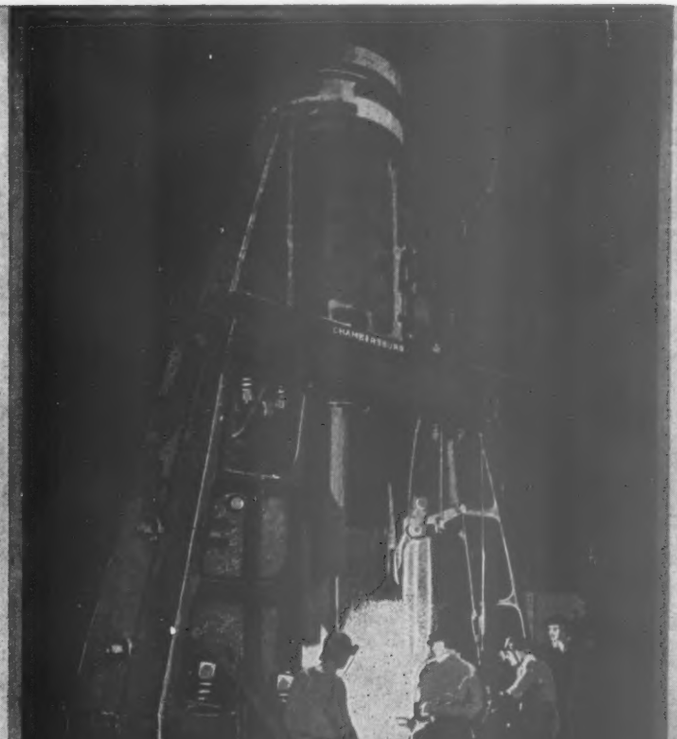
The prowess of Walter Snow Fighters, demonstrated for over 25 years on the highways of America and Canada, is proving just as outstanding for airport snow clearance. Write for detailed literature.

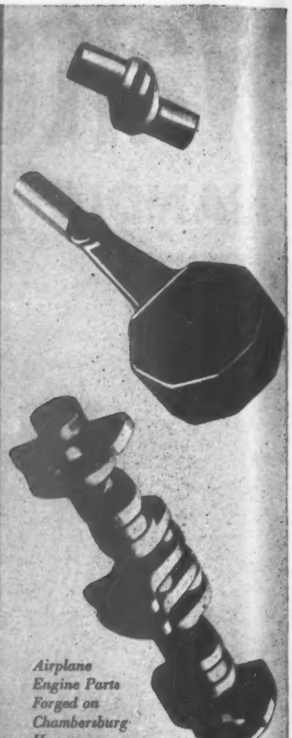
*U. S. Army and Navy—Royal Canadian Air Force.

WALTER MOTOR TRUCK COMPANY
1001-19 Irving Ave., Ridgewood, Queens, L. I., N. Y.



Specimen Tank Parts Forged on Chambersburg Hammers





Airplane Engine Parts Forged on Chambersburg Hammers

FORGINGS COME FIRST

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Forgings are vitally essential to the war effort because airplanes, tanks, ships and guns must be built to "withstand the unpredictable" . . . for which specification there is nothing to equal the strength and durability of the drop forging. ★ Before the cutting and grinding machine tools bring these parts to their final microscopic perfection, they are first forged to close limits, by tremendous impact between steel dies, in great drop hammers, such as those bearing the time-honored name of CHAMBERSBURG. Metal is saved, time is saved . . . and Victory brought closer . . . by the speed, power and accuracy of Chambersburg Hammers.

CHAMBERSBURG ENGINEERING CO., CHAMBERSBURG, PA.

THE CECOSTAMP

Airplane and other sheet metal parts of high strength alloys are formed quickly and without distortion on the Chambersburg CECOSTAMP.

The Cecostamp is an impact stamping machine of exceedingly flexible control, designed by Chambersburg Engineering Company specifically for the aviation industry.

CHAMBERSBURG

HAMMERS • CECOSTAMPS • PRESSES

(*Continued from page* 296)

Other replies, picked at random, show that Glenn L. Martin Co., Brewster Aeronautical Corp., Wright Aeronautical Corp., Boeing Airplane Co., Bell Aircraft Corp., Northrop Aircraft, Inc., Consolidated Aircraft Corp., Grumman Aircraft Engineering Corp., Ryan Aeronautical Co., Jacobs Aircraft Engine Co., Timm Aircraft Corp., Aeronca Aircraft Corp., Harlow Aircraft Co., McDonnell Aircraft Corp., Cessna Aircraft Co., Waco Aircraft Co., Taylorcraft Aviation Corp., Stinson Aircraft Division of Vultee Aircraft, Inc., and other aircraft manufacturers freely extend licensees, sub-contractors and others every facility for teaching their trainees quickly and efficiently how any part or assembly is made. In other words, every detail of manufacture is placed in the hands of what in normal times would be potential business rivals to help their men master plane production.

Methods vary in training personnel by established aircraft companies for other concerns that may some day prove stiff competitors. But if the aircraft industry realizes this, and it does, there is no slowdown in schooling such men. Some are trained in the airplane company's own plant, others are taught in their own city or plant by foremen and other technicians loaned by the aircraft concern. Text books are distributed, equipment is loaned. Even women are instructed by old-line airplane and engine companies how to perform tasks for licensees and sub-contractors.

Many of the companies replying to the questionnaire reported that they also taught members of the American and United Nations' armed forces in the maintenance, repair and servicing of their products in the field. Martin, among a group of others doing similar work for the Army and Navy, reported that in March, 1942, a program was launched to train 50 men from the armed services. This schooling has increased to a rate of 600 a month, or about 200 men every twelve days. The men are stationed at the Martin plant for 34 days, 28 of which are devoted wholly to instruction. The men live in dormitories and barracks at the plant, and are even fed there.

Consolidated Aircraft, from the other side of the country, reported that it had completed a camp site, known as Camp Corsair, and had begun the training of 600 Army men per month, loaning 36 instructors and much equipment. Pratt & Whitney, as an example of engine manufacturers, operates a special school for commissioned personnel of the Army and Navy, and has trained 573 men in engine and propeller service. P & W has also schooled military trainees from the United Nations and

(*Turn to page* 300)

TYPE G
Operating Wattage 0.05

TYPE B
Operating Wattage 0.012

Sensitive
RELAYS

Sensitive in their ability to operate with minimum wattage.

Ruggedly constructed to withstand the vibration and shock of Army and Navy equipment.

Meet all Army, Navy and CAA specifications.

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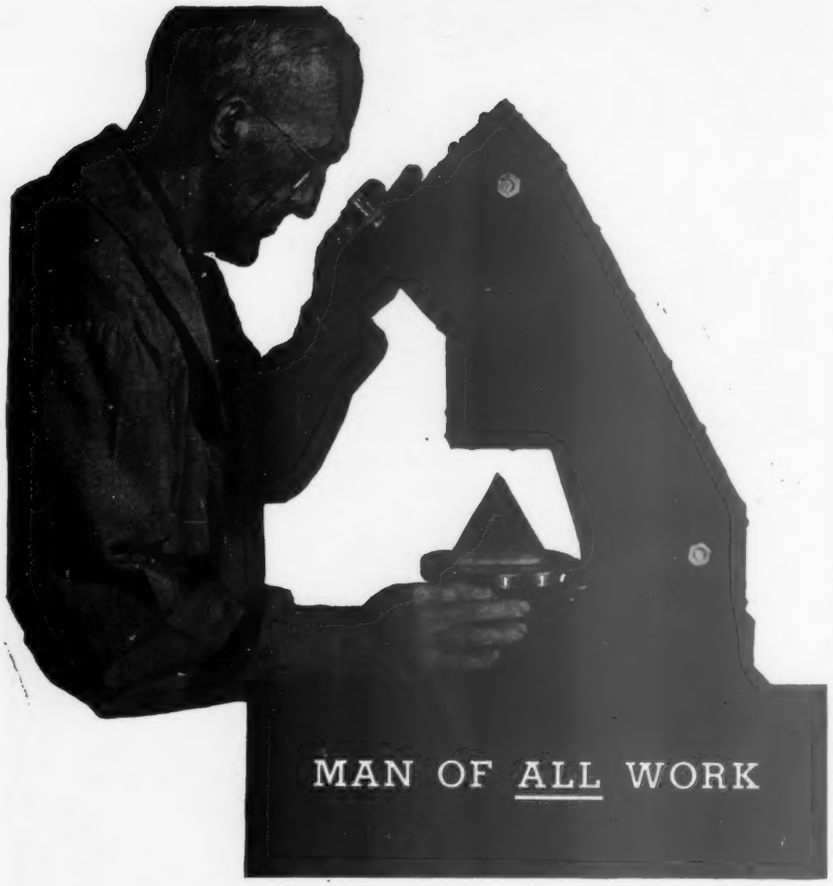


THE field of the optical engineer knows few boundaries. Naturally he is part and parcel of such sciences as astronomy and photography, but would you expect him to play an important role in a textile plant, a paint factory, the building of houses, or the discovery of defects in boiler tubes? These are but a few of the hundreds of assignments which Perkin-Elmer engineers have brought to a successful conclusion.

Today we are doing our bit for Uncle Sam. Precision manufacture of optical instruments and systems for Army and Navy needs has our whole attention. When Victory is won, the development and manufacture of new measuring devices, new control of industrial processes, new tools for research scientists, all will become of even greater importance than ever before. Then The Perkin-Elmer Corporation will stand ready to serve science and industry again, through the science of optics.

If you are already thinking ahead to post war necessities, you may want to know more about how optical engineers could be of service in your business. If so, we shall welcome your letter.

THE PERKIN-ELMER CORPORATION

GLENBROOK, CONNECTICUT

MANUFACTURERS OF PRECISION LENSES • PRISMS and MIRRORS

OPTICAL DESIGN AND CONSULTATION

(*Continued from page* 299)

South American countries.

The Wright Aeronautical Corporation operates a service school in which mechanics of the U. S. Army, Navy, Coast Guard, Marines, Ordnance Department, Armored Divisions and Air Forces in general of the United Nations, as well as commercial airlines, are trained in the special maintenance, repair and overhaul of Wright *Cyclones* and *Whirlwinds*. This school, founded in 1928, is the oldest service school in the aviation industry, Wright reported. It has moved to new and larger quarters five times to keep pace with its expansion

Bell Aircraft has established a school for the instruction of Army Air Forces mechanics in the servicing of Army P-39 *Airacobras*. Since April, 1942, approximately 1,000 men have been graduated from the intensive course. Boeing's Midwestern plant reported that it was making extensive plans to train members of the U.S. armed forces in maintenance, repair and serving of their airplanes.

Significant among the proofs of industry cooperation was Bell's statement that "subcontractors may discover new methods of speeding up production. They tell us, and we, in turn, when we make a discovery, tell them." Bell further reported that considerable technical information was exchanged in an effort to speed production. But it was also pointed out that to insure safety and secrecy, such important information was released only through channels set up and approved by the War Department.

Boeing, on the western fringe of the Middlewest, shares aircraft manufacturing honors with two other companies —Cessna and Beech—in its community. And although, in one instance, one company is a prime contractor and the other two are subcontractors, Boeing reported that all three companies were working together without prejudice or rivalry, except on the athletic field, where even the over-all feeling has been one of sportsmanship and Americanism first.

The survey further disclosed that Boeing feels that other and smaller companies should be assisted by the government through award of contracts to make aircraft parts so that American business in general should benefit. In other words, Boeing strongly emphasized its desire that other concerns, automotive as well as others, be given a share of the big orders being placed with the aircraft industry by the services.

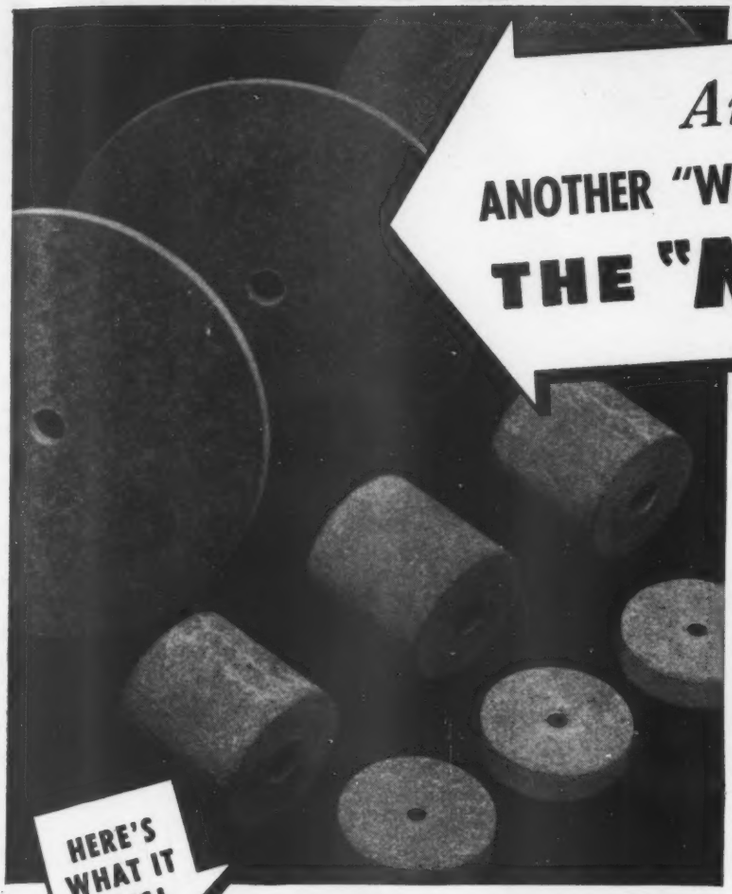
Wright Aeronautical also reported that it subcontracts its work in many cases where it would be possible for the company to save time by manufacturing the same parts in its own plants.

(*Turn to page* 303)

Announcing

ANOTHER "WEAPON FOR PRODUCTION"

THE "MX" WHEEL



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LESS than a year old, the "MX" Wheel is already making a name for itself as a "Weapon for Production." It is a free-cutting wheel capable of light stock removal and high polishing action at the same time. It requires but little pressure. It is used dry, since no coolant is required at the low cutting temperature developed. And its flexibility adapts it particularly for use in finishing and polishing out-of-the-way places on airplane engine parts and similar work.

Some typical applications are indicated by arrows on photos below. They include breaking down burrs or sharp edges on gear teeth, finishing and polishing splines and hard-to-get-at flat surfaces, depressed areas and various types of undercuts.

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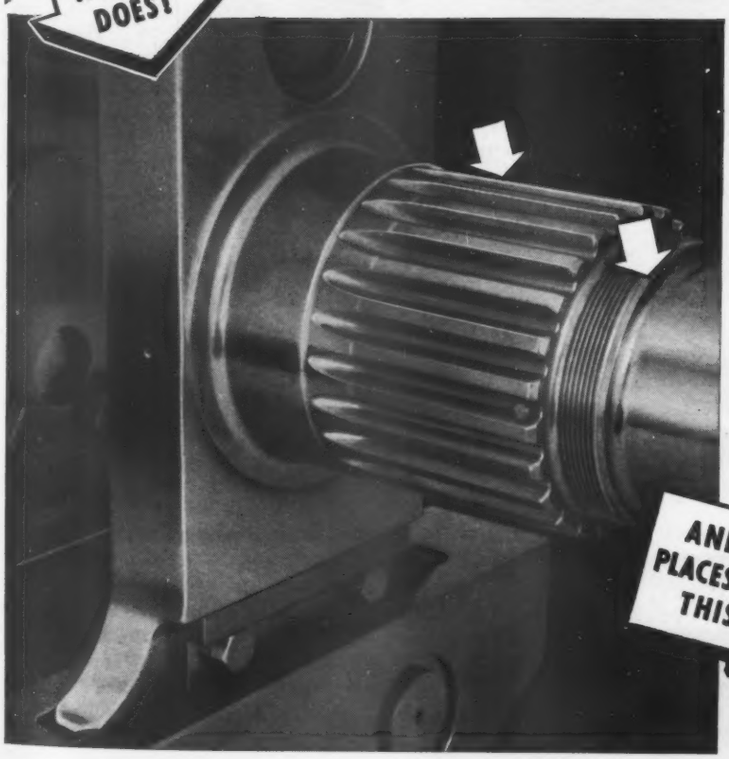

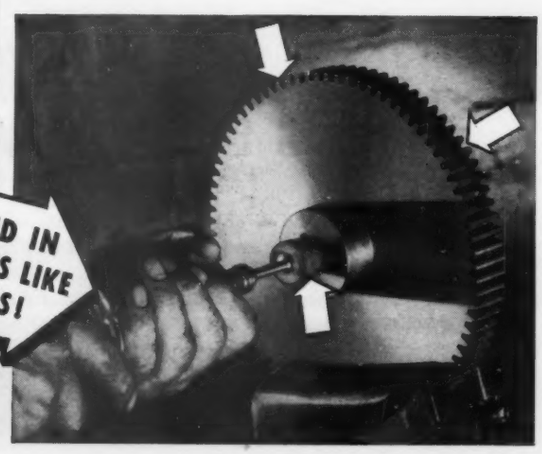

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The blood, and sweat, and tears of this war shall not be in vain. Nor shall the production facilities, the trained and experienced engineering personnel, or the loyal organizations of workers which are answering so magnificently the challenge to mechanized warfare be lost. Peace will find a place for these new creations of combat . . . a prominent place in the economic sun for the builders of the machines of war which can so readily be translated to the demands of commerce.

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CHANDLER-EVANS CORPORATION

MANUFACTURERS OF AIRCRAFT CARBURETORS, FUEL PUMPS AND ACCESSORIES

(*Continued from page* 300)

Wherever it has been possible, however, for the subcontractors to learn how to make parts that will meet quality control standards, with assistance by Wright technicians, subcontracts have been let in a spirit of full cooperation. The subcontracting procedure also allows Wright to use laboratory and shop space for manufacturing those parts which require a great deal of skill and which could not be handled by subcontractors.

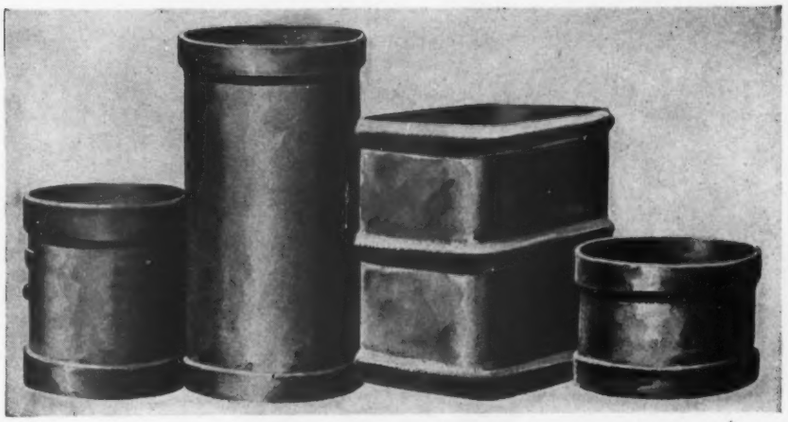
These typical examples are indicative of the scope of the ideas and work being carried on by members of the aircraft industry throughout the country in extending every assistance to civilian and armed personnel so that not only more and better aircraft may be produced quickly but that they may also be rapidly serviced and repaired in the war zones.

Four motor car manufacturers, General Motors Corp., Ford Motor Company, The Studebaker Corporation and Packard Motor Car Co., now engaged in aircraft work under license, reported that they also were exchanging information with other companies in the industry concerning many subjects, including the training of men for specific jobs, and some are engaged in teaching members of the U.S. armed services in maintenance in the field.

The survey provided plentiful examples of how laboratory analyses and engineering data had been exchanged even though many years and much money had gone into their development for private use. That is, for private use before Pearl Harbor. The government, of course, supervises the loaning and exchange of such highly technical and important information, but with sanction once received from Washington, aircraft companies are not holding back anything from anyone who may help increase production or evolve an improved product.

The aircraft industry has subcontracted wherever and whatever it could, without regard to whether an old established airplane manufacturer thought he might do the job better or at a profit to his company. While there is no sacrifice of quality, there is every effort on the part of the industry to give as much work to "outsiders" as is consistent with the high standards of airplane construction. And the matter of profits is ignored. The great majority of the aircraft industry replied that making money was a secondary consideration if a subcontractor could do a portion of their work and do it well to help speed the final craft on its way.

To the question whether any manufacturer had had the occasion to turn over materials to some other company, rival or otherwise, to tide them over a short-



A group of Carburizing Boxes made by The Pressed Steel Company. The type used by a large mid-western heat treater.

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The Cannon Plug shown above is a typical example of the adaptability of Cannon Connectors to a wide variety of uses. Its function is to break away, or become disconnected, under a predetermined load.

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age when the same stock might be used to advantage at "home," 90 percent of the companies replying stated that they had often rushed spare materials to other aircraft manufacturers. Either the stock was sold outright or loaned, and when the borrower received from his own source what he had had to seek from another aircraft builder, the loan was promptly repaid. Again, the loaning and exchange of such strategic material has been in full accord with WPB policy, and surplus materials are registered with the Aircraft Scheduling Unit at Dayton, Ohio.

As another random example of how the American aircraft industry is cooperating with its fellow members and outside manufacturers is a report by Aeronca Aircraft Corp. It seems that one of its peacetime competitors who is manufacturing a secret project similar to one produced by Aeronca asked for help in connection with a crating problem. One manufacturer had no trouble in shipping his equipment through without damage. But the other got reports that his product was slightly damaged upon arrival at the scene of action. Aeronca promptly provided full specifications on its packing procedures in order to safeguard the product of its one-time competitor.

The producers of airplanes, engines and accessories reported that they had seen in their own plants innumerable examples of what recently occurred to the American Propeller Corporation, a newcomer to the aircraft industry. This company, like many others strange to the ways of producing aeronautical equipment, received help on a method of brazing fillets in blades from a company that in normal times would not have dreamed of tipping off a competitor to a short cut in production. But, shortly thereafter, American Propeller returned the favor by developing a method of grinding blade shanks that effected important savings. This give and take in the aircraft industry and its newly developed licensees and subcontractors is almost universal. Mutual respect and confidence have been greatly increased through the wholehearted cooperation of the industry, as is evidenced by the examples which time and space has permitted us to list.

Other answers to AVIATION's query showed that members of the aircraft industry were not shy about admitting that other companies once considered outside the fold had helped them in building a better product and, in some instances, in building it faster. In other words, there was no hesitancy on the part of most companies to give full credit where it was due. This actually reflects with rich abundance on the aircraft industry itself for if outside con-

(*Turn to page* 307)

A Tough Spot for a Spring, too!

UNCLE SAM'S anti-aircraft guns make the skies a tough spot for enemy planes, but these fast-firing guns are also tough on their own component parts.

The recoil springs, for example, must absorb the terrific kick of powerful shells many times per minute—function flawlessly, despite the intense heat generated by such rapid and continuous action—and combat that arch enemy, corrosion, at all times. But Muehlhausen Springs are doing this remarkable job—for they are designed, fabricated and tested to meet the most rigid requirements; have that extra strength and stamina to take a real beating under all conditions.

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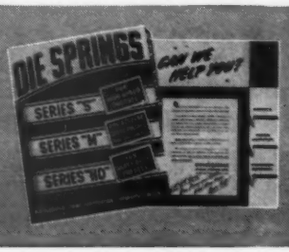
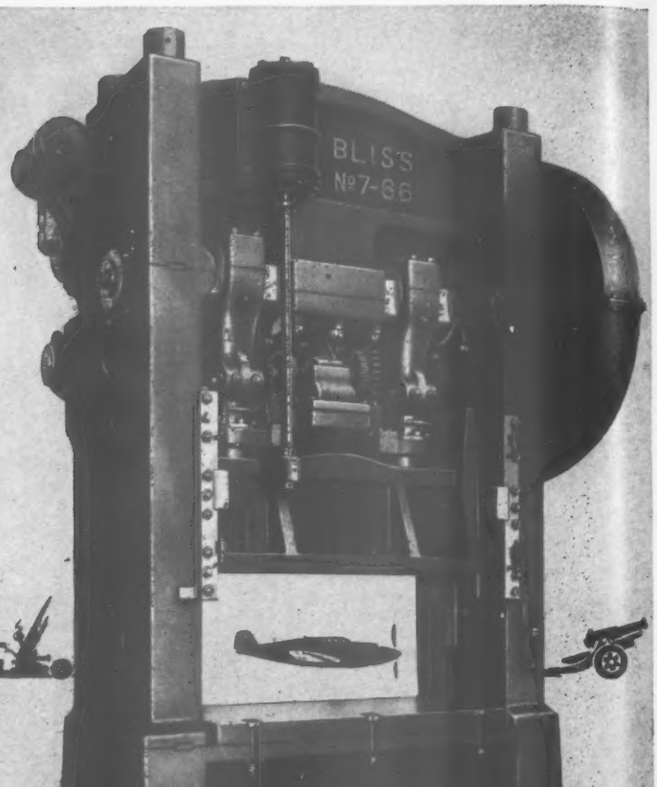
- New Armament Bulletin shows importance of springs for many types of war equipment.



Stamping for Victory



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cerns are able to help produce better aircraft faster, it is obvious that they must have been first well grounded and instructed in the intricacies of aeronautical manufacture by the old-line companies which, in peacetime, were the only concerns which had any knowledge whatever of their subject.

Many of the companies replying to the questionnaire reported that they occasionally actually met with other concerns to compare production schedules and methods, to exchange specific information of mutual value and to hold brief but important round-table discussions on how to build better aircraft faster. Such meetings are kept short because all parties to them are so rushed with production. But such friendly get-togethers are certainly indicative of the broad effort to help the other fellow, and to accept his assistance in turn if it will help speed the war to a successful conclusion.

Design and Combat Performance

(*Continued from page* 99)

These characteristics have to do with fighters as airplanes, but airplanes are also weapons. Chief military feature of a fighter plane is fire power, for in the last analysis no combat ship is better than its armament. It was the edge which the eight .30-calibre guns on the *Spitfires* and *Hurricanes*, plus slightly higher speed than the Messerschmitts and Heinkels, which was in large part responsible for winning the air battle of Britain.

Today eight .30-calibre machine guns is an absolute minimum, and most modern fighters have combinations of two to four 20-mm. cannon with two to four or more .30 or even .50-calibre machine guns. Instead of these mixed mountings, some fighters have four 20-mm. cannon —*Hurricane IIc, Spitfire Vc*—or six .50-calibre machine guns—*Warhawk, Thunderbolt*. This additional fire power is necessary owing to the greatly decreased vulnerability of modern bombing planes, with their higher speed, rugged construction, leak-proof gasoline tanks and armor protection. The heavier .50-calibre machine guns firing 800 rounds per min. are much more effective, and at greater distance, than the rifle calibre .30's which fire at a rate of 1,200 rounds per min.

American armament experts on the whole favor the .50-calibre gun, while most of the British, German and other foreign military aircraft use combinations of the 20-mm. cannon and .303-calibre or 7.7-mm. machine guns. This insistent demand for more fire power increases the weight, and thus reduces

(*Turn to page* 308)

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speed, especially the rate of climb.

Besides these three fundamental characteristics of speed, climb and fire power, fighter planes must have other performance features. Prominent is maneuverability, both for offense—to get the plane into firing position—or as the principal means of defense in combat.

A good fighter must have clear visibility to enable the pilot to scan the skies in all directions to discover his opponents and avoid being surprised. It must have good handling qualities for landing and taking off from small fields. It must be of simple, rugged construction for easy maintenance in the field, a very important feature, as time is at a premium in war, and grounded fighter planes may be worse than none at all.

These qualities have largely to do with what has hitherto been called the interceptor fighter, used defensively to intercept enemy aircraft. For protection of friendly aircraft in short-range operations by destroying the enemy's fighters, or providing an umbrella for task force operations fighter planes are used. (It should be noted that although the "P" designation remains, the term "pursuit" ship has been superseded by "fighter" as more generally suitable.) Another function of the fighter plane, however, is to escort bombers on long-range missions. As yet no country has been able to satisfactorily solve the problem of providing a fighter plane with sufficient gasoline capacity to give a range of, say 2,000 mi. (and this means a *radius* of bomber action not more than 800 mi., or 40 percent of range), without sacrificing such primary fighter characteristics as speed, climb and maneuverability.

It will be recalled that on the first raids over occupied France by our Boeing B-17E's, they were escorted by RAF and AAF pilots in *Spitfires*. These raids, such eye-openers to the British to the possibilities of daylight precision bombing, were all short run affairs. In a longer raid over the North Sea a few days later, as soon as the fighter escort turned back to England the last five of the eleven *Fortresses* were attacked by a swarm of Focke-Wulf and Messerschmitt high altitude fighters. Net result, one *Fortress* severely damaged, but all returned safely to base after dropping bombs on their targets; three Nazi planes down in flames and nine others destroyed or damaged. More spectacular results have since been achieved by both B-17's and B-24's.

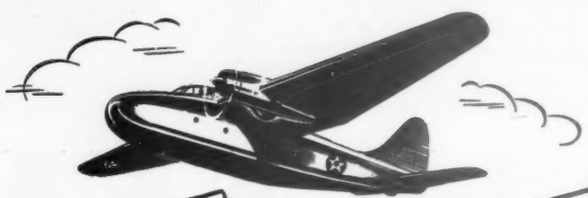
All of which illustrates two things. At present long range bombers cannot have fighter interference all the way. It is when the escort fighters leave that trouble begins and is likely to increase as the mission flies farther into enemy territory: in other words, at the very time when the fighter protection is most needed it is not available.

The other point is likely to make history. This incident, backed by scores of similar examples of B-17's in the Pacific area and an increasing number of instances of British *Stirlings* and *Lancasters*, proves that substantial progress has been made in the last year or so toward the ideal of a heavy bomber able to look after itself independent of fighter escort. Over and over again these bombers, and our two-engine Douglas *A-20's*, *Martin B-26's* and North American *B-25's* in every important theater of operations have demonstrated that their speed, heavy fire power and sturdy construction are more than a match for enemy anti-aircraft and fighter opposition. The pay-off to date is a B-17E which returned with two engines out of operation, tail surfaces almost shot away, riddled by nearly 1,500 bullet holes. In their first six weeks of action over Europe, *Fortress* gunners shot down 40 German fighter planes. Only two B-17's were lost.

The average tactical range of British and German single-seat fighters is

(*Turn to page* 311)

4 GLUES FOR FASTER WOOD PLANE ASSEMBLY



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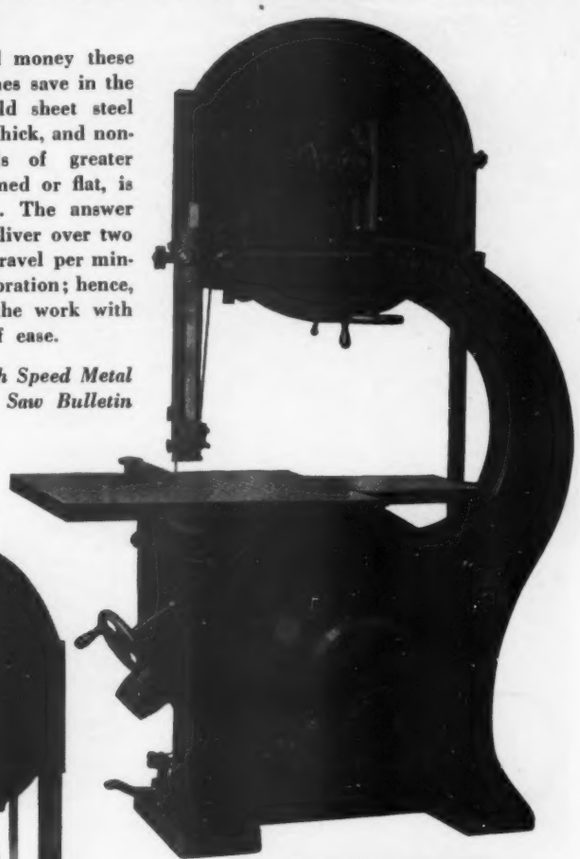

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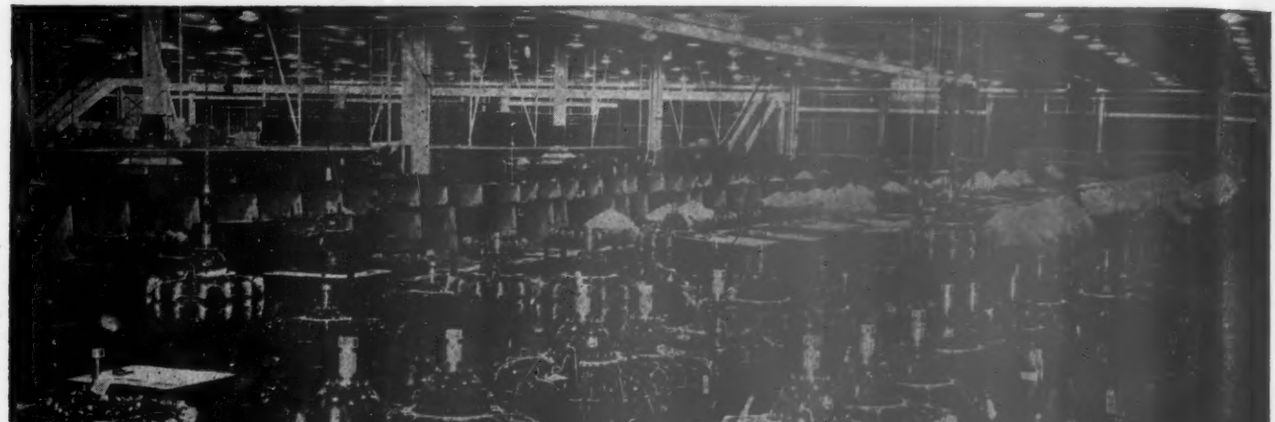

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(*Continued from page* 308)

600-700 mi., with a radius of action of 200 to 250 mi., or 35 percent. In heavy action, as a practical matter, it is considerably less than this maximum figure. According to *The Aeroplane,* clear-cut air supremacy can hardly be achieved with present equipment (*Hurricanes* and *Spitfires*) beyond a radius of 75,180 mi. Most American fighters and the Jap *Zero* have a maximum range of about 900 mi., the P-38 traveling considerably further. To increase the range for ferrying or strategical purposes jettisonable belly tanks have recently been provided. Until the difficulties of a genuine long-range fighter are resolved, and there are obvious advantages in having a fighter plane with sufficient gasoline capacity to stay in the air several hours, a partial solution will continue to be found in the use of fast, heavily armed two-engine bomber fighters, like the formidable Messerschmitt 110, tough, speedy Douglas A-20 or the powerful British *Beaufighter.* The latter two incidentally, are far and away the best night fighters now in operation, a highly specialized job in itself.

Thus the fighter, with all the conflicting qualities of speed, climb, firepower, maneuverability, visibility, ease of handling and maintenance added up, and with range thrown in for good measure, becomes more of a compromise than any other airplane type. The Army Air Forces award the design of a new type to manufacturers as a result of a competition based on announced general specifications. Merit is measured in terms of: (1) Performance, including speed, range and ceiling, 350 points; (2) engineering features, including structure, armament, powerplant and equipment installations, and maintenance, 350 points; and (3) military features, including general suitability, landing and takeoffs, arrangement of guns, etc., 300 points.

Too few people realize that many of today's first-line military airplanes are the result of tried and proved designs brought out six years or more ago, vastly improved as to speed, ceiling and firepower, but still essentially the same craft.

In the fighter class the best examples are the *Hurricanes* and *Spitfires.* In 1934 the British Air Ministry issued a specification for an eight-gun fighter with 1¾ hr. range at full throttle. (The knock-down, drag-out fight to get the *eight* .303 guns into the specifications was something else again. Such heavy armament was unheard of in those days, but the concentrated shotgun firepower thus provided saved England in 1940.) Using the Rolls Royce *Merlin,* both fighters were test-flown in 1936, came into limited production in 1937, and the first squadrons were outfitted in the summer of 1938. The *Hurricane* had a top speed of 335 mph., and the *Spitfire* 365. Improved versions of the *Merlin* and design refinements have more than kept pace with the demands for more protective armor and increased fire power, as the newest models are five to ten mi. faster than the originals and, in the case of the *Spitfire Mark V* the critical altitude has been boosted.

The German Messerschmitt Me-109 was brought out in 1936 and came into full production in 1937, its final design having been largely influenced by real combat experience gained in the Spanish Civil War. The same is true of the newer Russian fighter planes. This conflict set the seal on the monoplane with retractable landing gear as the fighter type of the immediate future. The Me-109 was originally designed for an engine of 650 hp. and was the first fighter to use a 23-mm. shell cannon firing through the propeller hub. Without material change of design the power plant has been successively stepped up to 850, 1,050, and now 1,150 hp., in the 109F. These successive rejuvenations brought the original speed

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of 265 mph. to 365 or better. Armament has remained the same, but after the failure of the Luftwaffe to smash the Soviet Air Force during the summer of 1941—an operation in which the Me-109E model was counted upon heavily—this fighter began to appear with protective armor plate. Recent reports from Russia indicate that the still newer Me-109G is in action, as a high altitude, partly armored fighter with a Daimler-Benz 603 liquid-cooled engine of 1,600-1,700 hp., armed with three cannon and two machine guns. The Me-109 has probably reached its limit in this newest model, but it still packs plenty of punch.

The year 1936 saw the advent of another famous fighter which was to make history, the Curtiss *Hawk 75* which carried the Army Air Corps designation P-36. Powered by a Wright *Cyclone* or Pratt & Whitney *Twin Wasp* 850-hp. radial aircooled engine it had a speed of slightly over 300 mph., somewhat faster than the Me-109 but slower than the *Hurricane* and *Spitfire* of the same vintage. All but the P-36 used V-type liquid-cooled engines. The decided edge in speed which this engine produced, accentuated by racing records by souped-up models, helped to swing Air Corps procurement policy toward it for the fighter planes. The highly successful P-36 was slightly redesigned to take the new liquid-cooled Allison V-1710 (then turning up 950 hp.) as the YP-37, which was developed into the P-40, A, B, C, (British *Tomahawk*), and the P-40D and E (*Kittyhawk*) with much heavier fire power, self-sealing gasoline tanks and increased armor. The newest model P-40F or *Warhawk* has the Packard built Rolls Royce *Merlin XX* engine and has a higher critical altitude and service ceiling than the earlier models, and according to reports from the various fighting fronts is already showing up in favorable action, although no details are releasable.

The one Army fighter which uses a radial air cooled engine, the Republic P-47 designed by Alexander Kartveli, can also trace a lineage back through the smaller P-43, and more indirectly to the P-35. Improved cowling, external streamlining, a highly efficient system of ducts for air cooling and turbo-supercharger, have combined to make the P-47 a speedy, powerful high altitude fighter.

The German Focke-Wulf 190, designed by Kurt Tank, draws many features from an early ancestor, the FW-159, first brought out in 1934-35. The FW-190 is powered with a BMW 801 14-cylinder, two-row air cooled radial engine of about 1,600 hp., and has a top speed of about 375 mph., with good rate of climb.* A newer version, powered by a BMW 802 engine of 2,000 hp. is coming into production and should prove to be a very tough customer. The Jap *Zero* also uses a 14-cylinder radial of about 1,000 hp., with a top speed of about 340 mph.

The British are standing pat on liquid-cooled engines for their fighters. The Bristol *Beaufighter* was originally powered with two Bristol *Hercules* 14-cylinder radials of 1,150 hp., but in the new *Beaufighter Mark II* they switched to liquid-cooled *Merlin XX's*, giving it greatly improved speed, rate of climb and service ceiling. The Army Air Forces is going ahead with developments of both liquid-cooled and aircooled types of higher power than anything now in production.

Heavy Bomber Development

So much for fighters and their engines. The story on bombers is substantially the same. An outstanding example is the Boeing model 299,** Air Corps B-17. This was designed in 1934

* Also see pages 228 and AVIATION, October, 1942, page 233.

** Also see The Truth About Our Bombers, AVIATION, October, 1942, page 96.

(*Turn to page* 315)

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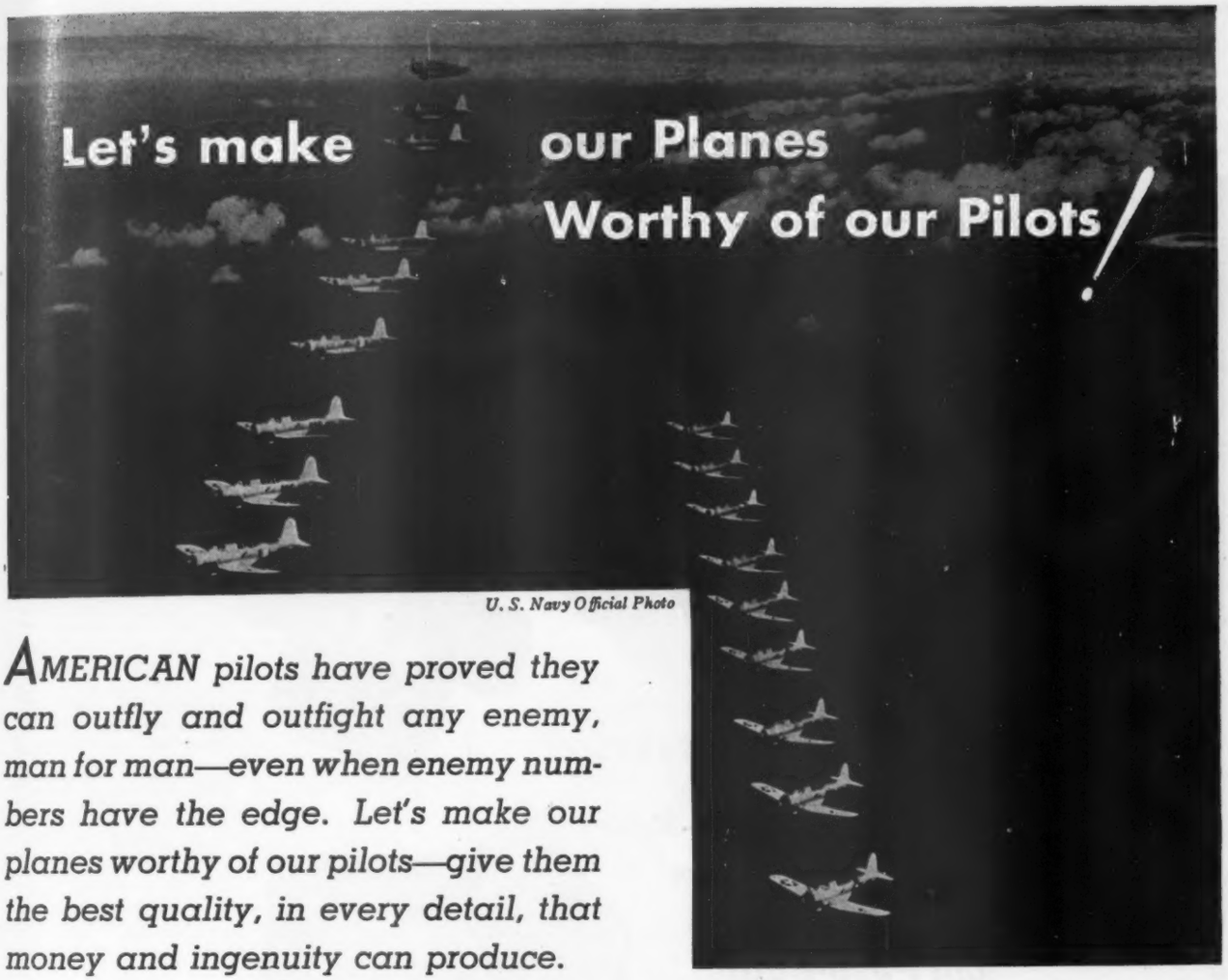

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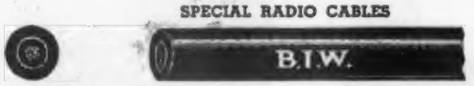

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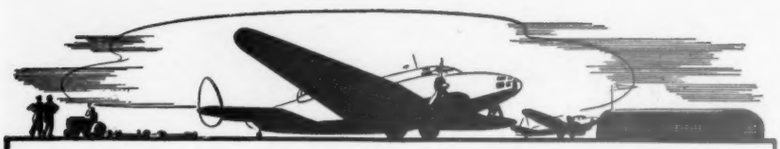

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(*Continued from page* 312)

as the world's first long-range four-engine heavy bomber to be the keystone of an American striking air force. It was test-flown in 1936 and its development by adding supercharging for high altitude operations, leak-proof gasoline tanks, heavy defensive fire power from .50 calibre machine guns firing from all angles—many from power-operated turrets—is a story full of examples of pioneering ingenuity. Its European vindication, after years of criticism, and equally amazing performance in the Pacific area, as a tough customer both offensively and defensively, speak for themselves. The original engines were 850-hp. Wright *Cyclones*, which have been successively stepped up to 1,250 hp., or a total of 5,000 hp. The B-17E in production by Boeing, Douglas and Vega has a top speed of over 315 mph. and weighs more than 30 tons, 10 tons of which is fuel and bombs.

Another interesting case history is that of the Heinkel He-111K, one of the most widely used bombers of the Luftwaffe. In late 1935 a fast, nicely streamlined twelve-place "commercial" airliner known as the Heinkel 111 was placed in service with the Lufthansa. Soon, however, a faster version came out, equipped with two Daimler-Benz 600 engines of 650 hp., the same engine as the original Me-109. With a speed of about 235 mph., it went into service with the Luftwaffe and was used in Spain. It was further stepped up with 800 hp. Jumo 211's, then 1,000-hp. Daimler-Benz 601's and finally, as the Heinkel 111K-5 with D/B 601A's of 1,150 hp. With these modifications and other improvements, top speed went from around 200 to about 275 mph., the original armament of three 7.7-mm. machine guns was doubled and a 23-mm. shell cannon added, all manually operated. (In fact, the Germans have been very backward in their use of power-operated turrets.) Still widely used, the He-111K has a service ceiling of 24,000 ft. and a range of 2,000 mi. with a light bomb load.

Up to the advent of the British four-engine heavies, one of the most consistently successful long-range bombers was the Vickers *Wellington*, "Wimpy" for short, and familiar in this country as the plane in the motion picture "Target for Tonight." The prototype appeared in 1936, the first production job in late 1938, and by the middle of 1939, just before the kick-off of World War II, an RAF Bomber Command squadron received its equipment of *Wellingtons*, powered by Bristol *Pegasus* nine-cylinder air cooled radials of 965 hp., with a speed of 235 mph. at 15,000 ft., its critical altitude. Wicked looking gun turrets with two .303's in the tail and nose and one from cabin windows on each side provided good defensive armament. Range was about 1,500 mi. with a ton and a half of bombs. Its unique geodetic construction made for slow production but was exceptionally sturdy. Wellington *Mark II* came out in early 1941 with two Rolls Royce *Merlin X's* of 1,150 hp., which improved speed, ceiling, range and bomb load. The *Mark III* and *Mark IV* are now in service, powered respectively by Bristol *Hercules* and Pratt & Whitney *Twin Wasps*, both 14-cylinder aircooled radial engines of 1,300 to 1,400-hp.

No Substitute for Time

These examples of fighter and bomber development in Britain, the United States and Germany are far from exhaustive, but illustrate the immense value of having well established designs ready before the shooting starts. Many other examples could be given to show the time required before a brand new design is ready to be put into full scale production and combat operation, but two or three will suffice. The Bell P-39 *Airacobra* was designed in 1937-38, the prototype test flown in the spring of

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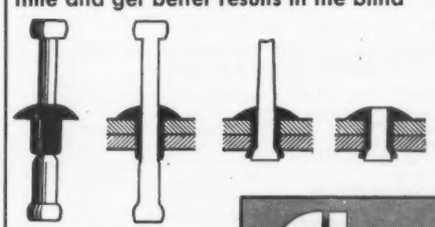

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1940, good production was reached by autumn of 1941, and it was thrown into action on various fronts during spring of 1942. The twin-engine Lockheed P-38 was test-flown across the country in February, 1939, in about 7½ hr., hitting over 400 mph., while crossing the Alleghenies. It has an official NACA rating of 404 mph. at 16,600 ft. However, it was thought to be too heavy—around seven tons—and in all nearly 2,000 changes were made down to the model P-38E, which was in good production from late 1941, and in action by late spring of 1942.

The Republic P-47 is the first American fighter designed since the outbreak of war to see action. Based somewhat on the Republic P-43, the only Army Air Forces fighter type using a radial air cooled engine, the Turbo supercharged P-47 design was completed in September, 1940, the prototype was test-flown in May, 1941, improvements made and limited production achieved by the spring of 1942. The advanced model is coming off the lines at the parent factory in good volume and two other plants are now going into large-scale production.

These three fighters as well as the Curtiss *Hawk* series, went through the usual sequence of design award, prototype, exhaustive tests, award of contract for production in quantity, then tooling-up at factory. The Martin B-26, fastest and most powerful of its type in the air, broke this tradition by tooling up for quantity production first on the chance of success and a resulting large contract. When the first B-26 flew in late November, 1940, it was a production model and several others were nearly ready. It is now well known that it landed too fast, and there were the usual bugs to be ironed out. This has been done, at least two full years were saved, and now the plane is doing its deadly damnedest on a dozen fronts, doubling in brass as the world's fastest land based torpedo bomber in the actions at Midway and the Aleutians.

Other planes are now coming along on this telescoped plan, as our greatest battle has been against time. Some of these have already been test-flown and will be in production by next spring and, speaking generally, the speeds, bomb loads, fire power, ceilings, and ranges of these new bombers and fighters will be breath-taking. A principal factor in this stepped-up performance will be improved engines, with or without the use of higher-octane gasoline.

Looking at the Record

When all is said and done, however, the acid test of a military airplane is

(*Turn to page* 319)

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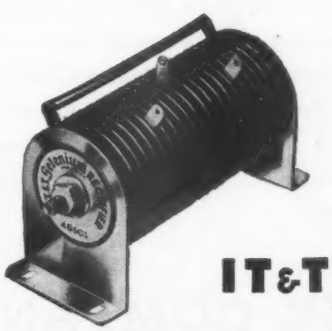

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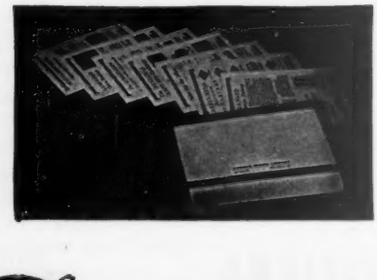

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(*Continued from page* 316)

its record in combat. Do fighters knock off enemy fighters and bombers, or do they get knocked off? Do bombers get through to their targets, drop their loads accurately, and get back to do it again, despite enemy fighter and anti-aircraft opposition? On the whole, so far in this war, the combat record of American planes has been good, and it is getting better fast. Our heavy bombers have turned in amazing performances, and the new B-17F's and B-24-E's in large-scale pooled production have been further improved with far greater bomb loads and flexibility between range and load. Our medium bombers are highly praised for their speed, striking power, and high degree of invulnerability. The A-20's and B-25's are powered by Wright 14-cylinder *Cyclones* of 1,700 hp. and the B-26 by Pratt & Whitney *Double Wasps* of 2,000 hp. As a matter of fact, except the practically untried Dornier DO-217-E2, powered by two BMW 802 18-cylinder 2,000-hp. radials, there are no medium bombers anywhere to match them.

In the fighter class it is admitted that for high altitude work we have not yet been able to match the best fighters of Britain, Germany and Japan, but the high-flying P-38 and P-47 will soon be in wide-scale service, and on the basis of tests and operational reports to date should amply take care of things "upstairs." Accounts of the performance of the P-38's in the Aleutians and the southwest Pacific indicate that their speed, rapid climb, high ceiling and terrific fire power are just what the doctor ordered to rub the rim off the Jap *Zero*, and this combination of qualities, together with a much longer operational range than the *Spitfire*, should prove equally effective against the Focke-Wulf 190 in the European area. In the lower levels, where much of the fighting still takes place, our fast, well armed and well protected P-39's and P-40's are shooting down enemy planes on all fronts, in some areas on a better than 4-to-1 basis. The British are immensely pleased with the North American P-51, which not only handles beautifully and is easy to service, but is said to outrun the speedy *Spitfire* at levels below 20,000 ft.

In the widely scattered theaters of operation, supply and service is a vital consideration, and our rapidly expanding world-wide air line under the Air Transport Command, and maintenance set-up of the Air Service Command's overseas division have become as important as any of the fighting outfits.

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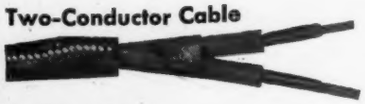

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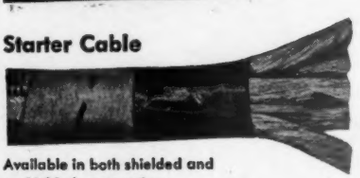

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tem of flexible-quantity production, avoiding the danger of Germany's original over-confident freezing of designs. There are indications that the Nazis have corrected this to some extent in that the FW-190 fighter and Do-217E-1 bomber have been in operation about a year with 1,600-hp. engines. These two airplanes, designated FW-290 and Do-217E-2, may well prove to be serious contenders for a place in any list of the world's "best" planes. However, new American designs hinted at above, and British models should be in operation as soon as these Luftwaffe planes, and there is little doubt that the qualitative edge of United Nations' military aircraft will continue to be maintained. Already we are ahead on a monthly production basis and this advantage will be further increased. Incidentally, in any selection of the "best" planes, the main point of this article should be kept in mind—a particular airplane is "best" suited for its designed purpose. Without a common yardstick, comparisons between planes are frequently unfair. To cite one example, in the heavy bomber category it may be freely granted that the British *Lancaster* is "best" at the moment for very heavy night bombing of Germany, but any list that fails to take account of the amazing 'round the world record of the Boeing B-17 and Consolidated B-24 will hardly gain acceptance by a majority of aviation authorities.

No country has a corner on aeronautical developments, and the race for quality calls for research and still more research. Air power is today proving a decisive factor on many of the fighting fronts, and will eventually lead the way to victory. But victory alone is not enough. Peace and goodwill are the only worthy goals, and here again air power can show the way.

Side Slips

(*Continued from page* 195)

man enemy, for the sea birds flew to battle both from the land and from their floating cotes. Some of these floating cotes were dashed beneath the waters, but before they went their winged *Wildcats* and *Avengers* bred by Grumman and their Douglas-bred *Dauntless* and *Devastators* took many, many times more of the yellowman's floating cotes and forts.

Even the giant egg layers worked against the critics. Not only did they lay eggs precisely in the appointed parts of the earth but these Boeing and Consolidated-bred *Flying Fortresses* and *Liberators* proved to have a striking power almost beyond the imaginations of some of the critics. The little yellowmen called these birds four-engine pursuit ships, so effective was their striking power.

Such actions bode ill for the critics, leaving them farther and farther out upon the limbs of their predictions. More amongst the multitudes began to say, in the quaint jargon of the day, "Let's look at the box score." And ye old box score made very good looking indeed.

And as more of the multitude turned to the box scores the words of the critics lost in their market value; no longer did they and booksellers reap harvests of gold; no longer did the journals of the day give space to their carpings, no longer did people flock to the lecture halls to hang upon their words.

And there finally came a day when one of the multitude, hearing the critics quoted as oracles, rose to his feet and demanded, "Just who the hell are these guys who say our warbirds have such a stench?"

Speed Propeller Production

(*Continued from page* 151)

It was also determined that in order to produce the required volume on one machine it would be necessary to produce three complete retainers for each pass or stroke of the machine.

Now the rectangular bar stock is fed through a trough into the machine by a hydraulic floating clamp, which eliminates distortion of the bar stock and friction in the feed mechanism.

Instead of milling out the center of the bar stock, three slotting broaches cut in from the side of the bar stock to an accurate tolerance and thus three individual pieces are slotted at one stroke. The bar then automatically feeds to the next position with special index features assuring proper alignment.

The second operation is the forming of the three radii on the opposite side of the bar from the side which has been slotted. This is done by means of a special forming broach. Again the bar feeds to the next position and the piece is indexed.

The third operation is the parting of the first three units—those which have been slotted and on which the radii have been formed. This is done by means of hacksaws operating as broaches.

When the machine is in operation and the bar stock has started to feed, all three operations are performed simultaneously and at each stroke of the machine three complete units are ejected.

An analysis made since this specially tooled LaPointe broach has been in operation discloses that the cost per unit for the spring pack retainers has been reduced 75 percent.

LOOKING FOR TROUBLE

TO keep the Allies' supply lines open, to enable us to dispose men, munitions and food where they are wanted, demands utmost efficiency to the last detail.

Aircraft looking for trouble and ready to destroy the menace that comes from under the sea, ships, guided by men ceaseless in their vigilance, dodging this trouble, all are dependent on the absolute reliability of engines both in aircraft and ships.

The job of work Vokes Filters have to do is to ensure that the air, oil and fuel oil servicing engines is free from impurities so that maximum power and speed and complete dependability can be assured. Vokes Filters, under the severest battle conditions in all areas of fighting on land, sea and in the air, have stood up to demands made on them. Exacting tests in nearly three years of war in all branches of the services has substantiated the claim for Vokes Filters —99.9 per cent. FILTRATION EFFICIENCY UNDER ALL CONDITIONS.

TOP—VOKES OIL FILTER FOR AIRCRAFT. CONTINUOUSLY REMOVES ALL IMPURITIES TO 0.00004 IN. DIA. RESISTANCE NEGLIGIBLE, NO INTERRUPTION OF OIL CIRCULATING.

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WESTON

Receives the Army-Navy "E" Award

"On LEADERSHIP rests the responsibility for getting things done."

Only short months ago, the instrument goal in this mechanized war seemed unattainable. In almost unbelievable quantities instruments were needed for our huge plane program—for a two-ocean navy—for tanks, guns and walkie-talkies — for our arsenals and factories — and for countless new devices of war.

To approach this goal meant far more at WESTON than the mere addition of factory and laboratory equipment, and the usual worker-training program. It meant imparting to untrained hands the skill and instrument sense which ordinarily takes years to acquire. For it's this rare instrument sense, backing up sound engineering, which has been responsible for WESTON's continued leadership.

This "E" award to the workers at WESTON—the first to any group in this specialized field—means recognition of their efforts in striving to attain the goal in numbers, while never relinquishing the WESTON quality ideal.

And to our courageous fighting men everywhere, it conveys the assurance that they can depend on the men and women at WESTON to continue furnishing the essential instruments in ever increasing quantities . . . *until victory is won.*

WESTON ELECTRICAL INSTRUMENT CORPORATION, NEWARK, N. J.

Heliarc Welding

(*Continued from page* 147)

a magnesium bearing ore, are in Montana, Washington, and British Columbia.

Contrary to popular belief, magnesium alloys are not inflammable when properly processed; in fact they are more resistant to direct flames than aluminum alloys. Although magnesium alloys are 35 percent lighter than aluminum alloys and 21 percent of the weight of steel per unit volume, their weight strength ratio is comparable to aluminum alloys, and they possess the design property of stiffness and rigidity that cannot be obtained in other alloys. With these properties of magnesium alloys in mind, together with the rapid production method of attachment and aerodynamic advantages which heliarc welding presents, the future use of magnesium alloys for the fabrication of structures, especially in aircraft, should be greatly enhanced.

Magnesium castings containing foundry defects have been repaired with this process and welds equal to or stronger than the surrounding metal have been obtained. The weld metal is much more dense than that of the surrounding cast metal and far less susceptible to corrosion. Almost any thickness of cast metal that can be poured may be readily welded with this process.

Welding rod of the same alloy as the parent metal is usually used for castings and wrought alloys. The weld ingot appears to have better corrosion-resistant properties than the parent metal in salt spray tests. The weld bead appears to be cathodic to the adjoining metal, which causes minor pitting of the original metal adjacent to the weld under severely corrosive conditions.

The tungsten electrode is very slowly alloyed with the weld metal and naturally in a period of time the tungsten electrode must be replaced. No noticeable increase in the corrosion rate of heliarc welds in magnesium alloys because of the presence of tungsten has been noticed.

Heliarc weld ingots have in general an extremely fine grain with practically no grain enlargement adjacent to the bead, indicating that there is a minimum of heating effects on the adjacent metal. This accounts for the very good weld efficiencies obtained on heliarc welded alloys.

Dowmetal J-IH magnesium alloy, heliarc welded, has approximately 95 percent of the parent metal strength in the weld area. However, at present the design safety factor for welded dowmetal J-IH assemblies is 75 percent of the strength of the parent metal. These strength values are based on butt welded joints. Fillet, lap, edge, or corner welds are weaker than the butt welded joint and must be stressed accordingly.

Heliarc welding has proven to be a successful medium of attachment for magnesium, stainless steel, brass, inconel, monel, and some of the carbon steel alloys. Research work is now in progress to extend its use to aluminum and other carbon steel alloys not heretofore heriarc welded. In the heliarc welding process, a shield of helium gas envelops the molten metal. Because helium gas is an inert gas, it prevents oxidation and eliminates the use of a flux and the danger of entrapped flux in the weld ingot that would promote corrosion. The arc in this process is produced directly between a tungsten electrode and the base metal rather than between two tungsten electrodes as is the practice in atomic hydrogen welding.

The Northrop heliarc welding torch is equipped with a helium valve that is opened just prior to the striking of the arc between the tungsten and the parent metal which feeds helium through the torch to the weld. Helium has over five times the specific heat of air and when in motion prevents heat accumulation around the weld thereby keeping it cooler and giving a better fusion and penetration with less distortion than other welding processes. The arc is struck by a light brushing action and quickly drawn back from the metal.

Northrop Aircraft has designed heliarc torches which will shortly be available to the industry. The torches are of two sizes to handle 1/16 in. to $\frac{1}{8}$ in. electrode and $\frac{1}{8}$ in. to $\frac{1}{4}$ in. electrode respectively and may be supplied with tips of different angles, 40 deg., 60 deg., and 90 deg. The torch may be used for pencil welding or, by extending the handle a handle bar grip is obtained for heavier welding. A type of torch will later be available that feeds the filler rod automatically, giving more uniform results than where the rod is fed by hand. Best results are obtained by feeding the filler rod into the tungsten electrode which melts off portions of the rod thereby casting a uniform weld ingot. This procedure has been found to be superior to the practice of feeding the filler rod into the molten pool under the arc, whereby the molten pool is not sufficiently agitated to break the crust which gathers on the surface of the pool. Since the reflected heat from the tungsten overheats the filler rod, an angle of 60 to 90 deg. must be maintained between the filler rod and the electrode. The tungsten electrode varies in size from 1/16 in. to $\frac{1}{4}$ in., depending upon the thickness of metal welded and the heat required. The torch must be held as near the weld as possible to obtain maximum benefit from the helium for the prevention of oxidation. Also an arc length of 0.060 in. maximum should be maintained. Poor penetration or gas holes may result by using too long an arc. On those alloys that have a tendency to be hot short, a rapid welding speed is recommended, approximately 3 ft. per min., to eliminate the danger of cracking.

A conventional arc welding machine with direct current generator having a 150 amp. output is desirable. However, higher output machines which operate at less than 300 amp. may be used providing lower amperes may be obtained. An upright machine is preferable in that it is easier to attach a helium tank to such a unit. Separate amperage and voltage regulators must be provided and the machines should have a continuous sequence of five increments of current control. The average life of a 200 cu.ft. helium tank is about 35 hr. of continuous welding with a medium-sized torch. Fairly pure helium gas is required. Normally helium as purchased from the government plant is sufficiently pure to cause no difficulty. Additional gases in helium such as carbon dioxide, hydrogen, nitrogen and the hydrocarbons may cause pronounced defects. Hydrogen produces bad porosity. Oxygen films the metal causing poor coalescence and inclusions. The presence of 7 percent nitrogen in the helium reduces the welding speed to about two-thirds that obtained when only 2 percent is present. All of these gases if present, may be removed, however, by passing the helium through filtering mediums.

This method of arc welding has provided an important new tool for the

Demonstrating heliarc welding of magnesium. Welding rod of the same alloy as the parent metal usually is used for castings and wrought alloys. Helium, regulated by a finger control valve on the handle of the torch, flows out of an electrically insulated cup around the adjustable tungsten electrode.

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LEXINGTON AVE., AT 48TH ST., N. Y. C.

fabrication of structures from alloys such as magnesium and stainless steel. Any type of joint which has been commonly used for welding ferrous metals may be employed on magnesium and stainless steel.

Stainless steel has heretofore been the most difficult alloy to weld and could only be satisfactorily arc welded by the use of atomic hydrogen, and then only on thicker sections. By the heliarc welding process, thicknesses of less than 0.010 in. may be very easily welded. In the heliarc welding of stabilized stainless steel the extent of carbide precipitation is very low as compared to other methods of welding which greatly increases its fatigue factor. The medical profession would do well to consider this process for the arc welding of stainless steel braces in bone surgery where spot welding and other means of attachment have not been so successful.

In the heliarc welding of magnesium structures a tungsten electrode is used with reversed polarity making the magnesium the anode. For ferrous and copper alloys, a carbon electrode is used and the welded structure is the cathode. Craters are eliminated in reverse polarity welding.

For the high temperature melting and heat resisting alloys heliarc welding has proved successful where other welding methods failed. Heliarc welding gives the greatest penetration of any known welding process.

Patents

(*Continued from page* 153)

Aircraft Structure, 2,296,117, P. Pevney, assignor to Republic Aviation Corp. A flush type retractable landing gear housed in the wing structure and projectable therefrom for landing. Embodies a worm of the double enveloping type combined with bearing means.

Method and Apparatus for Pickup and Delivery by Aircraft in Flight, 2,295,537, V. R. Anderson, assignor to W. H. Woodin, Jr. Relates to a method in which greater speeds are obtainable and in which unloading and loading may be rapidly accomplished without landing. A novel type of load carrier is provided.

Driving Means for Mechanism for Multi-motored Airplanes, 2,296,006, H. Wagner, vested in the Alien Property Custodian. A driving arrangement whereby all the various mechanisms, such as electric generators, blowers, pumps, and moving parts, such as flaps, elevators, gear and the like, may be selectively driven by any one or all of the airplane motors.

Airplane Stall Indicating Apparatus, 2,296,528, R. D. Lacoe. An electric warning indicator which does not operate until the plane approaches flying speed, but provides a signal when the plane is in flight and the angle of incidence changes to a predetermined point.

Aircraft Fuel System, 2,296,876, D. Samiran and R. B. Poole. A system designed to eliminate the tendency of such fuel systems to vapor lock at high altitudes or when the aircraft is subjected to high accelerations during rapid maneuvers.

Aircraft Motor Gearing, 2,297,214, F. Gosslau, vested in the Alien Property Custodian. A large driving unit for aircraft having outputs of 2,000 and more horsepower. In star-connected series motors the output of the various crankshafts is transferred to the propeller by means of intermediate shafts provided with clutches.

Spinner for the Hubs of Airscrews, 2,297,226, by W. Muller-Keuth and E. Engert, vested in the Alien Property Custodian. A means for securing the spinner to the hub of the propeller, through which spinners of any diameter may be easily attached and detached. The rear or free edge of the spinner is supported and guided by means of a rear support fixed to the back of the propeller hub.

Glide Path Producing Means, 2,297,228, E. Dramar, vested in the Alien Property Custodian. A radio direction finding system for aircraft in which the production of a glide path is accomplished in accordance with the principle of field intensity comparison between two radiation patterns.

Aircraft Engine, 2,297,237, F. Nallinger, vested in the Alien Property Custodian. Designed to cut fuel consumption on long flights at high altitudes. An additional transmission step or additional transmission range is added to the gearing which is arranged between the driving engine and the charging blower.

Driving Mechanism for Air Propellers, 2,297,400, A. Friedrich, vested in the Alien Property Custodian. Relates to the type in which the driven shaft is swingingly coupled at one end with the driving shaft yieldingly supported in the hull body of the aircraft.

Apparatus for Indicating the Approach to the Stalled Condition of Airplanes, 2,297,412, F. Hoppe, vested in the Alien Property Custodian. Two measuring tubes are provided, the nascent difference in pressure between them causing a direct action upon the control of the craft, in order to return the plane to its normal position.

Exhaust Conduit Assembly, 2,297,425, K. Meissner, vested in the Alien Property Custodian. The invention is directed to the assembly of a plurality of exhaust conduits into a compact bundle, and a cowling for covering this bundle and for conceaiing flaming gases emitted from the conduits.

Bombsight and Pilot Director, 2,297,448, A. Baroni, vested in the Alien Property Custodian. The finding of the direction of attack is reduced to a sighting operation to determine instantly the necessary approach so that an accurate order of operation may be transmitted to the pilot. It is based on the use of the vector triangle of velocities.

Ventilation of Altitude Cabins, in Particular for Aircraft, 2,297,496, H. Pfau, vested in the Alien Property Custodian. The output of the turbine is rendered smaller, through preheating, than the efficiency which the compressor must take up, and the difference is produced through a controllable electrical engine.

Elastic Mounting, 2,297,506, F. Schmidt, vested in the Alien Property Custodian. Does away with auxiliary struts for stiffening the engine mounting by providing an elastic bearing which has elasticity characteristics radially of the bearing which allow greater elastic movement in one radial direction then in another radial direction.

System for Landing Aircraft, 2,297,515, R. von Ottenthal, vested in the Alien Property Custodian. Designed to produce several glide paths by means of a single arrangement. The glide path characteristic is made effective in a number of directions at the same time.

Prevention of Ice Formation, 2,297,540, E. A. Driscoll. An automatic means in which the necessary electrical conductors are made in extra light form. It becomes automatically effective at the start under ice forming conditions.

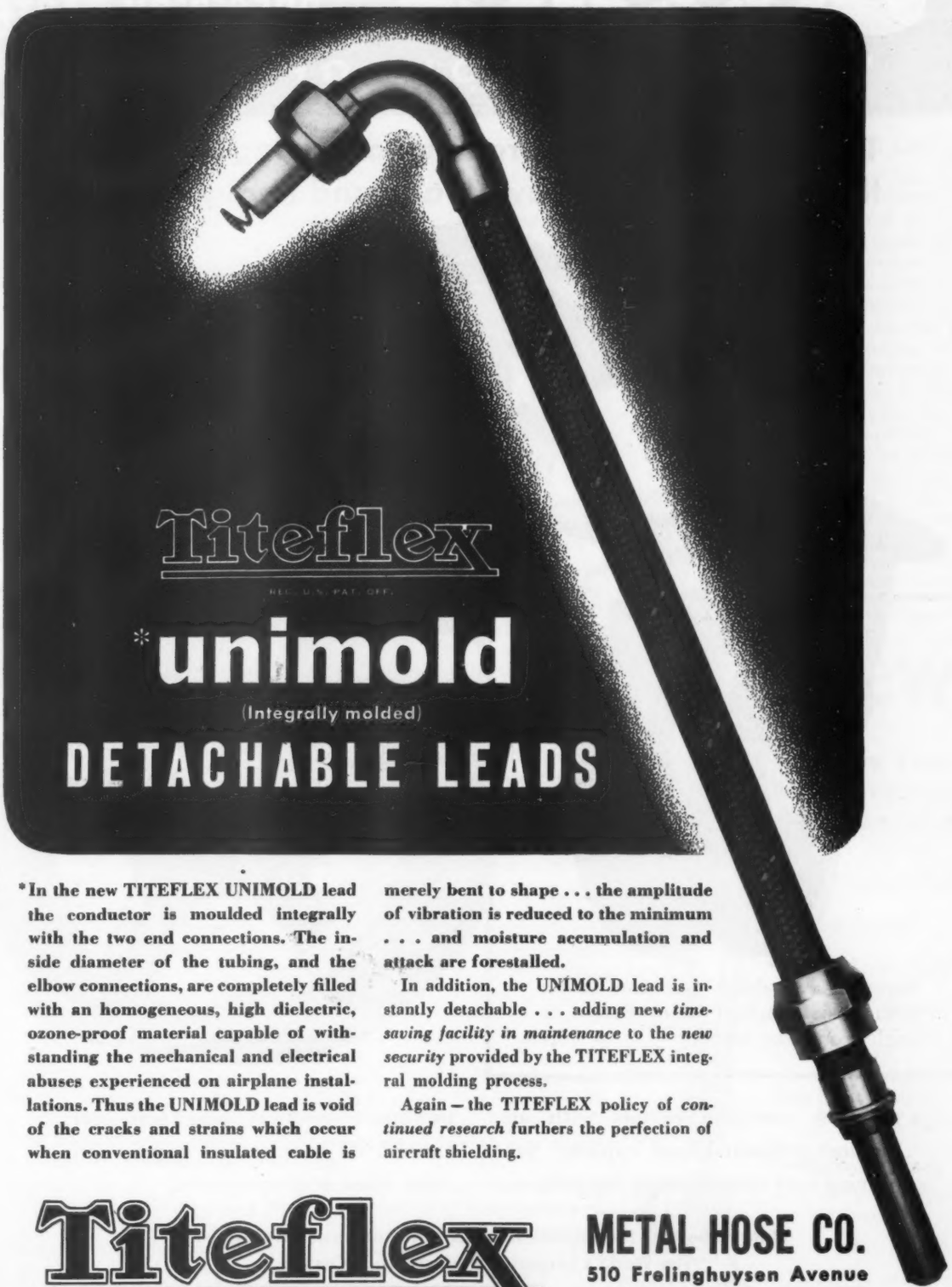
Employee Feeding

(*Continued from page* 105)

from plates to teacups in no time at all. The whole operation is handled along the same lines of mass production efficiency as are employed on the factory floor.

(*Turn to page* 327)

NEW SECURITY FOR AIRCRAFT IGNITION SYSTEMS



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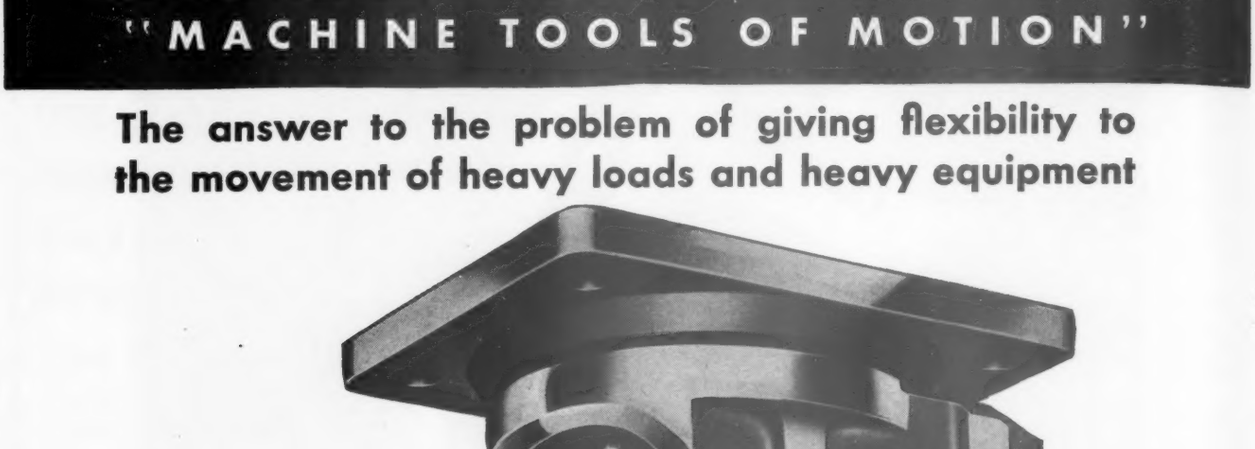

Super heavy duty precision caster with grooved wheel for operation on angle iron floor track.

Bassick precision casters with an almost unlimited load capacity are giving easy movement to the production lines of new heavy cargo transport aircraft, PT boats, heavy engines and other vital war equipment.

Write to Bassick for engineering assistance on caster problems . . .
The World's Largest Manufacturer of Casters.

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Canadian Factory: Stewart-Warner-Alemite Corporation of Canada, Ltd., Belleville, Ontario

(*Continued from page* 324)

Yet, amazingly, the food retains a home-like quality. There are three reasons for that: Only the best ingredients are used; formulas employed were originally developed from small quantity recipes; the chefs are absolutely required to follow every formula to the letter.

Mechanics of the whole cafeteria arrangement are beneficial to the organization as a whole in addition to the individual employee. The company doesn't have to worry about the complex problems of mass feeding—that detail is all handled by J. L. Stevenson and John Thompson, director and assistant, respectively, of the welfare organization.

It is significant that besides modernizing the cafeterias in its older plants, Douglas is including complete mass-feeding set-ups in all of its new factories where size justifies this step.

Of course the question arises as to whether workers are inclined to take full advantage of the food service facilities. Douglas finds that if the food is good, if it's conveniently available and if the prices are right there's no problem on this score. Other factors being equal, most any employee prefers a hot meal to a cold sandwich.

At one Douglas plant, which is a good testing ground since it's been in operation only a few months, about 72 percent of all the workers are eating three meals a day in the cafeterias and branch canteens. Of course the lunch and dinner figures would run still higher.

Douglas is said to be the only aircraft manufacturer serving breakfasts for all shifts. There's good reason for this. The man working peculiar hours is the one most likely to neglect his breakfast—he doesn't like to get the wife out of bed and so he's likely to grab a cup of coffee and rush off to work. As a result, he doesn't work at top efficiency until after lunch—and maybe not then.

Since breakfast is the only meal being served during the early morning hours, no particular preparation problem is involved then. But there is a trick in having breakfasts ready for men who come on during the middle of the afternoon or at night. Those people aren't consistent in their habits—sometimes they eat at home and again may patronize the cafeteria. To avoid loss in over-preparation and to keep from upsetting kitchen routine—it's tough to prepare two types of meals for serving at the same time—the Douglas people select items which are suitable for either breakfast or dinner use—things like steaks and chops and eggs.

The men who have breakfast in the cafeterias almost invariably eat substantial breakfasts—foods such as steaks and eggs and hot cakes and potatoes.

Display Appearance Sells Balanced Meal

When Douglas first began experimenting with food service, the management expected that educational effort would be necessary to sell workers on balanced meals—particularly in view of the fact that a cafeteria set-up was going to be used. But attractive food display has eliminated the need for anything of that type. Salads and vegetables which many men are inclined to pass up at home are made so attractive that employees buy them of their own accord. A casual check of tables in one cafeteria showed that about 93 percent of those eating lunch at that time had selected dietetically balanced combinations.

One thing that contributes to this favorable situation is the care taken to bring out the colors in food. In the serving line all foods are alternated by colors and, wherever possible, attractive color contrasts are arranged in the individual dishes. For example, when a white stew is served, there's always a bright vegetable to go with it—beets for instance.

Wherever possible, cooked foods—both those served individually and the ones used as ingredients—are kept whole and are prepared in such a way that they'll retain full, natural color. Large pieces of cooked beets and carrots, for instance, look just like they did before they went into the kettle. Even the berries in pies—Douglas uses only quick-frozen ones when the fresh are out of season—remain whole when they're served.

Then, lighting is planned to emphasize natural food colors. At one of the new cafeterias, red and daylight fluorescent tubes are combined so as to highlight both reds and greens—yet to avoid glare. The pastel walls here are easy to look at, create a cheerful, restful atmosphere.

As still another means of stimulating employee appetites, menus are planned far enough ahead that the same entrees aren't served more than once in 18 days—usually not more than once in 22 days. Employees are never given a chance to tire of any one set of foods.

In the same way, workers are kept from tiring of the surroundings in which they eat. Every time a new supply of waitress uniforms is ordered—about once in four months—the design and color are changed completely. Even the placement of tables is changed from time to time—insofar as is practical.

"The psychological factor is of tremendous importance," says Welfare Director Stevenson. "If you've ever eaten in restaurants consistently, you know that even though the food standard in a given place remained constant, you seem to tire of it after awhile. That's human nature—we all require some change. Since our people don't alternate from one restaurant to another, we have to provide that needed change—both in food and surroundings—within our own cafeterias."

System and Speed of Service

One of the biggest problems of all, Douglas found, is that of systematizing service so that a maximum number of people can be fed in a minimum amount of time. This problem involves several factors including cafeteria location, size, arrangement and actual serving routine.

Since even the smallest Douglas plant covers many acres, the matter of distances to and from the cafeterias was an important consideration. If all people had to come to a single, centrally located food service department, many of them would use up a good part of their lunch hours going and coming—and Douglas believes that hurried eating is just as detrimental as improper food or a lack of food.

So, the company has arranged to bring the cafeterias just as close to the work-

ers as possible. In some cases that means use of two or more main cafeterias. In others, branch cafeterias are required. In still others, supplementary service is offered in both portable and stationary canteens.

In one of the newest plants, the cafeteria—this one has 14 double serving lines—is situated in a glass lean-to right on one side of the main production building. This being a concentrated plant in which most of the production is centered in a single huge building, the one large cafeteria here will do the job—for the time being at least.

Another new plant uses two main cafeteria locations, one on a mezzanine directly above the main production level and a second in the administration building.

The more common plan, and the one which is perhaps best suited to most older plants, is to install one main cafeteria in a fairly central location and then set up smaller serving branches at as many outlying points as are necessary. One of the newer installations which has been in operation long enough to test its practicability, may, for the purposes of this discussion, be considered as a model. Here, one main cafeteria where all food is prepared and eight temporary branches do the job. Under general supervision of the welfare division, a caterer, the H. S. Anderson Company, operates the cafeterias for this plant.

The latter are housed by temporary structures which can be moved at will to fit the current need. There's nothing fancy about the fixtures here—just long tables and benches. But the food is tops—and it's hot. Each branch set-up is equipped with a complete portable steam table, refrigerators for ice cream and other similar products, coffee urns and soft drink coolers. The food is brought to the branches in insulated carts which are hauled in trains—by electric trams. These carts also return the dishes.

Size of the main cafeterias is sufficient for *preparing* all food that would be required for feeding 100 percent of the employees when the full limits of personnel are reached. Serving capacity here, however, is designed only to meet the needs of workers stationed in nearby buildings. The peak demand is kept within reasonable size by staggering of lunch hours over a 2-hr. period.

In every case, the cafeterias have been arranged to minimize traffic congestion—both in the serving lines and in the table section. At the new plant mentioned, for example, two serving sections are used, both located along one end of the building. The lines feeding into those service areas form on two sides of the building. From the serving sections, employees move past cashiers and on out into a wide *center aisle*. From here they may fan out in either of two directions to the table area. Besides speeding up service, this arrangement eliminates exterior lines—and the disadvantages which go with them in blackouts or bad weather. Incidentally, a light-trapped entrance is used, equipped with lines of luminous paint, so that service may continue at any time.

At the end of the cafeteria opposite the serving line is a soda fountain where as many as 20 malted milks can be mixed at one time. This section speeds light lunch and between-meal service and frees table space for those who eat hot dishes.

The serving line and table arrangement, plus a highly efficient serving routine under which every waitress has definite duties to perform at every moment of the meal period, permit the serving of from 31 to 32 people per minute in the main cafeteria.

"Traveling Lunchrooms" in Some Plants

In a few cases where neither the central cafeteria nor branches could adequately handle the load, Douglas has resorted to portable food carts or trucks. These are equipped with built-in refrigerators, hot food storage compartments and coffee urns. In one case, eight men operating these trucks sell around $450 worth of food at the lunch hour. To conserve labor, employees from other departments are used for this job, are paid a percentage of the "take" for their noon-hour efforts.

Another variation of the standard set-up is the stationary canteen, a self-sustaining food supply center which serves light lunches and specialty foods and beverages to supplement employee lunches brought from home. These departments are usually furnished with a combination griddle and broiler, a large refrigerator and other supplementary equipment. Their specialty is hamburgers.

With its widely varied food service facilities, Douglas has done everything possible to bring good, hot food within reach of the workers—in location and in price. The set-up is fitted to the needs of each individual plant.

Candy, Coca Cola and Vitamins

But despite all its expansion in hot meal service, Douglas hasn't overlooked the original aims of the welfare division's founders—to provide flash energy for workers between meals. Every plant is equipped with scores of conveniently located soft drink and candy bar machines. And, an employee may take a moment off at any time to patronize those vendors.

Nearly all employees use that privilege—but few abuse it. Candy consumption runs nearly a bar per day per employee. The Douglas production record attests to value of this food.

The final step in this company's food program has been the sale of packaged vitamins at cost. Bought in huge quantities, the price of vitamins is brought down to where every worker can afford them—and the great majority are taking advantage of this opportunity to build reserve energy and greater health.

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TENNEY ENGINEERING, INC.
8 Elm Street Montclair, N. J.

Maintaining Arc Welders

(*Continued from page* 136)

infrequent circumstances will cause serious impairment if not complete interruptions of their service.

One bad practice, for example, is that of leaving weather-protecting tarpaulins thrown over machines in operation, in such a way as to interfere with the free passage of ventilating air into and out of the equipment. Cases are known where welders have been equipped with canvas flaps permanently installed on inlet and exhaust air openings, resulting in severe overheating and

(*Turn to page* 331)

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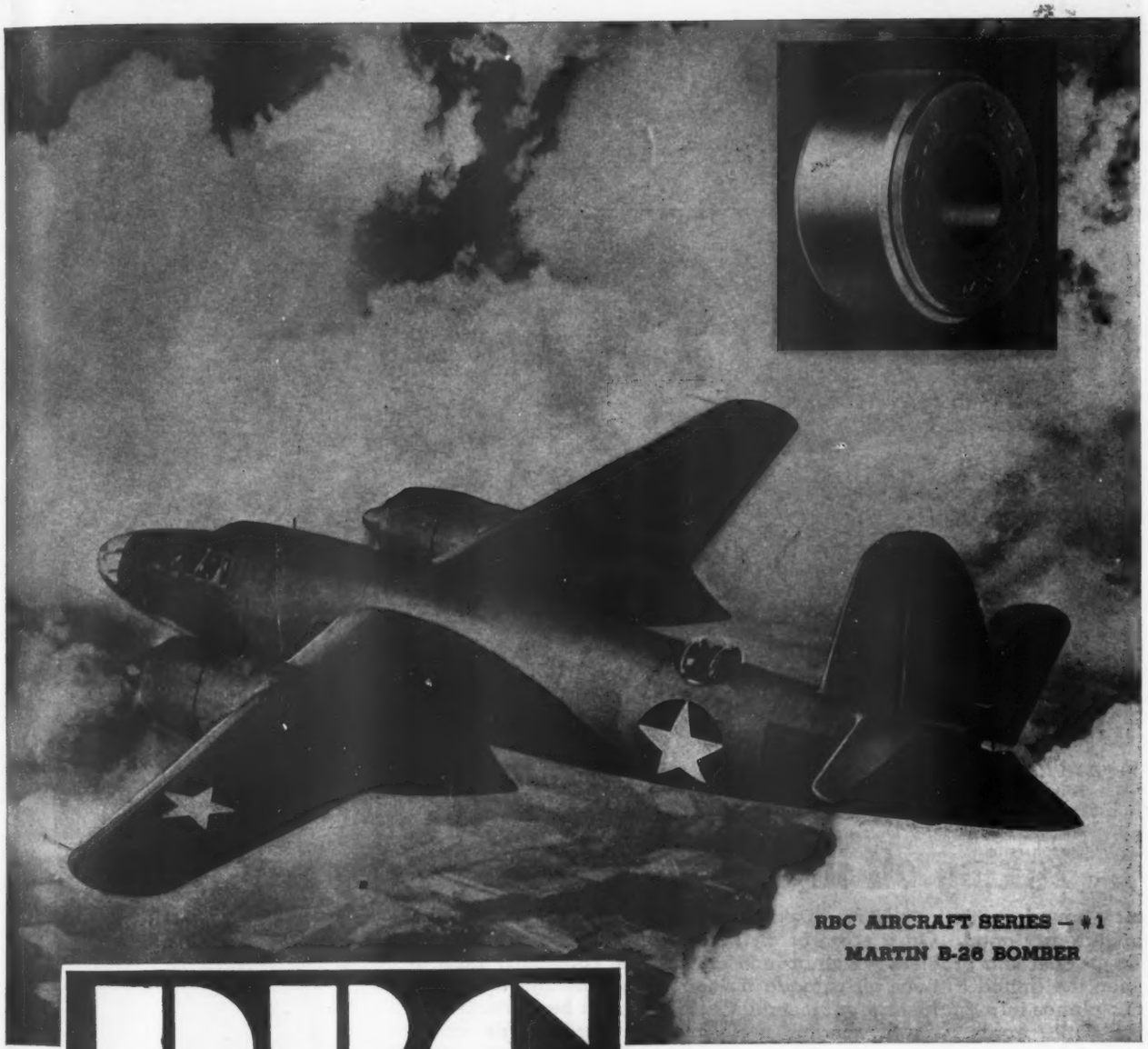

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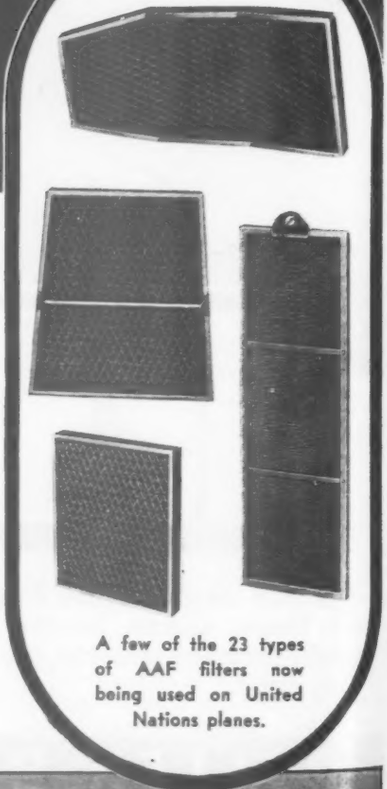

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AAF **AIRPLANE ENGINE FILTERS**

(*Continued from page* 328)

very short equipment life.

Improper connection of extension leads for either the electrode or work terminals is not at all uncommon. This results in a high resistance circuit from welder to arc and return with resulting variations in welding current, particularly when the leads are moved so as to change the resistance of the connections. This is a frequent cause of complaints by welding operators that the heat is not steady. The remedy for this is to make sure that connections are kept tight, and that all connections are made with cables equipped with properly installed cable lugs or terminals. It is practically impossible to bolt or wedge untinned flexible cable to another conductor and secure a good low-resistance joint. Soldered or reliable solderless connectors or terminals should always be used.

The use of excessively long electrode or work leads with motor-generator type welders will result in overheating of the motor when operating in the upper part of the current range unless extraordinarily large cables, or a number connected in parallel, are used. Overheating of the motor from this cause is a frequent reason for motor-generator welders tripping off the line with consequent loss of production.

A source of trouble which is not protected against by the motor overload relays is the intentional or unintentional application of long continued short circuits on the generator. Poor cable or cable connection insulation may be responsible for unintentionally short circuiting a generator for long periods of time. This results in the flow of very heavy generator current, but because of the low generator voltage involved, does not require sufficient power input from the line to cause the motor overload relay to trip. While the motor is not damaged, the generator may be seriously overheated or burned out. The same results will follow intentional permanent short circuiting of the electrode holder on the work or any grounded conductors.

The use of improperly bonded structural steel systems or building frameworks for the welding current return circuit is undesirable. The high resistance path thus afforded the welding current may result in overheating of the welder motor, and in addition, there is always the possibility that arcing or overheating of some poor connection, possibly quite remote from the scene of operations, may go unnoticed and start a fire.

No attempt should be made to adjust welding current output by any means other than those provided and recommended by the manufacturer of the equipment. Shifting the brushes on generators not designed for brush-shifting control will usually result in inferior welding characteristics, impaired commutation, and short brush life. Short circuiting of resistors or rheostats or any other tampering with the control furnished on arc welding equipment may result in damaging or burning out the equipment.

In transporting welding equipment, rough handling resulting in permanent mechanical damage is all too frequent. Motor-generator sets mounted on steel wheeled running gear should be moved only at slow speeds—never behind fast-moving trucks or other vehicles. They should be eased over obstacles and depressions such as flange clearance groves in tracks. Slings used for transportation of welders by crane should be carefully arranged to avoid damaging control boxes, handles, and other equipment mounted on the outside of the set.

Care should be taken to avoid using arc welders outdoors in unfavorable weather. Many machines now on the market are designed to be both semi-protected and drip-proof. This does not mean, however, that these welders should be used in rain or other precipitation without suitable protection.

At the discretion of the user, of course, drip-proof or even open motor-generator sets can be operated outdoors, provided they are protected from obviously damaging conditions by tarpaulins or temporary shelters. These must be arranged so as not to hinder ventilation of the equipment, as previously discussed.

Thunderstorms

(*Continued from page* 103)

characteristics noted over the Muskingum Watershed. Fig. 7, an exceptionally good picture of cumulonimbus clouds taken south of Akron, Ohio on July 16, 1934, shows such a family of thunderstorms, widespread heavy rainfall due to thunderstorm activity. The rainfall pattern produced by these thunderstorms would be similar to that produced by the groups of thunderstorms described in the first part of this article. The anvil portions of the clouds which indicate the motion of the air aloft substantiate the schematic flow patterns shown in Fig. 4.

There are other possible reasons for the rapid dissipation of thunderstorms. The rapidly supplied explosive energy or the shearing effect of higher wind velocities aloft could so distort the cell that the streamlines would be shifted, causing an appreciable amount of rainfall in the forward part of the cloud. The cooling effect of rain falling through this part of the storm would be the same as that described for the rear of the storm and the establishment of a descending cold column of air in front would cut off immediately the supply of warm moist air. This would cause the storm to dissipate as rapidly as it began.

Petterssen[4] has shown that if a translatory movement is superposed on a convective current the streamlines are essentially as shown on Fig. 4. This is also in agreement with streamlines shown by Humphreys[3] on page 355 of his book *Physics of the Air*. If, then, we can assume that the portion of the air in the cloud follows these streamlines it will be seen that most of the raindrops which form, or at least the heaviest rain, would be confined to the rear portion of the cloud and little would fall from the forward part of the cloud. The violent downrush of cold air in advance of the center would carry the heavy rain approximately along the streamlines while in the rear where the velocity has greatly decreased it would be coming approximately straight down. Theoretically then the width of the area of heavy rainfall would generally be less than three-fourths the width of the body of the cloud.

Evaporation from the falling rain continuously saturates air adjacent to the rear portion of the thunderstorm cloud so that as the thunderstorm progresses the central portion of the cloud grows backward as indicated by the dashed line on Fig. 4. In the final stages the cloud would look similar to the commonly observed anvil cloud with the rear portion relatively flat and the cirrus overflow extending well in advance of the main body of the cloud.

The good agreement obtained between wet bulb temperatures aloft and the resulting surface temperatures in a thunderstorm, and between the value of observed and computed squall winds, suggests that a considerable or even an "explosive" amount of energy can be supplied to a thunderstorm through evaporational cooling due to the falling rain.

The vertical circulation in a thunderstorm as suggested by Humphreys and Petterssen seems to be substantiated by the agreement in wet bulb temperatures aloft and the resulting surface temperatures as well as by observational and theoretical considerations.

One of the most vivid descriptions of the motions in a thunderstorm and one which confirms some of the suggestions made is that recounted by Shaw.[5]

"The following interesting account by Prof. John Wise of one of his balloon experiences is valuable as strong confirmatory evidence:

'According to announcement I started on Saturday last on my forty-first aerial

excursion from the Center Square of Carlisle, at precisely fifteen minutes past two o'clock in the afternoon, it being the 17th of June, 1843. A slight breeze from the west wafted me a short distance in its direction horizontally, after which the ascent became nearly perpendicular until the height attained was about twenty-five hundred feet, when the balloon moved off toward the east with a velocity much greater than that of its ascent. When I had reached a point about two miles east of the town, there appeared a little distance beyond and above me a huge black cloud. Seeing that the horizontal velocity of the balloon would carry it underneath and beyond the cloud, preparations were at once made to effect it by throwing out some ballast as soon as its border should be reached. Harrisburg was now distinctly in view, and the balloon moved directly for it; I was hesitating, with the bag of ballast in my hand, whether I should throw it out for the purpose designated, or continue straight on as I was then going to the place just mentioned. By this time I had reached a point underneath the cloud, which was expanding, and immediately felt an agitation in the machinery, and presently an upward tendency of the balloon, which also commenced to rotate rapidly on its vertical axis. I might have discharged gas and probably have passed underneath it; but thinking that it would soon be penetrated, and then might be passed above, as it appeared not to be moving along itself, I made no hesitation in letting the balloon go on its own way . . . The cloud, to the best of my judgment, covered an area of from four to six miles in diameter; it appeared of a circular form as I entered it, considerably depressed in its lower surface, presenting a great concavity toward the earth, with its lower edges very ragged and falling downward with an agitated motion, and it was of a dark smoke color. Just before entering this cloud, I noticed, at some distance off, a storm-cloud from which there was apparently a heavy rain descending. The first sensations I experienced when entering this cloud were extremely unpleasant . . . The cold had now become intense, and everything around me of a fibrous nature became thickly covered with hoar-frost, my whiskers jutting out with it far beyond my face, and the cords running from from my car looking like glass rods, these being glazed with ice, and snow and hail was indiscriminately pelting all around me. The cloud, at this point, which I presumed to be about the midst of it from the terrible ebullition going on, had not that black appearance I observed on entering it, but was of a light, milky color, and so dense just at this time that I could hardly see the balloon, which was sixteen feet above the car. From the intensity of the cold in this cloud I supposed that the gas would rapidly condense, and the balloon consequently descend and take me out of it. In this, however, I was doomed to disappointment, for I soon found myself whirling upward with a fearful rapidity, the balloon gyrating and the car describing a large circle in the cloud. A noise resembling the rushing of a thousand milldams, intermingled with a dismal moaning sound of wind, surrounded me in this terrible flight. Whether this noise was occasioned by the hail and snow which were so fearfully pelting the balloon I am unable to tell, as the moaning sound must evidently have had another source, I was in hope, when being hurled rapidly upward, that I should escape from the top of the cloud; but as in former expectations of an opposite release from this terrible place, disappointment was again my lot, and the congenial sunshine, invariably above, which had already been anticipated by its faint glimmer through the top of the cloud, soon vanished, with a violent downward surge of the balloon, as it appeared to me, of some hundred feet. The balloon subsided, only to be hurled upward again, when, having attained its maximum, it would again sink down with a swinging and fearful velocity, to be carried up again and let fall. This happened eight or ten times, all the time the storm raging with unabated fury, while the discharge of ballast would not let me out at the top of the cloud, nor the discharge of gas out of the bottom of it, though I had expended at least thirty pounds of the former in the first attempt, and not less than a thousand cubic feet of the latter, for the balloon had also become perforated with holes by the icicles that were formed where the melted snow ran on the cords at the point where they diverged from the balloon, and would by the surging and swinging motion pierce it through.

'. . . Once I saw the earth through a chasm in the cloud, but was hurled up once more after that, when, to my great joy, I fell clear out of it, after having been belched up and swallowed down repeatedly by this huge and terrific monster of the air for a space of twenty minutes, which seemed like an age, for I though my watch had been stopped, till a comparison of it with another afterward proved the contrary. I landed, in the midst of a pouring rain, on the farm of Mr. Goodyear, five miles from Carlisle, in a fallow field, where the dashing rain bespattered me with mud from head to foot as I stood in my car looking up at the fearful element which had just disgorged me.

'The density of this cloud did not appear alike all through it, as I could at times see the balloon very distinctly above me, also, occasionally, pieces of paper and whole newspapers, of which a considerable quantity were blown out of my car. I also noticed a violent convolutionary motion or action of the vapor of the cloud going on, and a promiscuous scattering of the hail and snow, as though it were projected from every point of the compass.'"

Flight Considerations

Several comments and suggestions are offered for pilots when they find it necessary to fly through a thunderstorm area or squall line:

In approaching a line or group of thunderstorms it is always safest to appraise the situation and decide on the course to be pursued before attempting to fly through them.

The greatest vertical velocities and most severe turbulence are usually found in the upper two-thirds of a thunderstorm cloud. Severe turbulence and a violent swirling and rolling motion are usually present in the lower forward portion of the cloud. The roll scud which forms in this part of the cloud gives some indication as to its elevation.

Unless it is absolutely necessary, never fly directly into a thunderstorm cloud. If there is no choice it is usually safest to avoid the central lower forward portion and fly in or along the edges or just below the base of the cloud providing the altitude of the base is 1,500 to 2,000 ft. above the ground. The vertical velocities in this portion of the thunderstorm are the least but frequently the turbulence and the change from an upward to downward current or vice versa are sufficient to cause an airplane to rise or fall abruptly for a considerable distance. The plane should be high enough to enable the pilot to regain control if these conditions are encountered.

In flying through a thunderstorm there is always the danger of running into severe hail. It at all possible it is best to fly below the clouds and around the area of heavy rainfall.

If it is necessary to fly above the base of the clouds in an area where there are general thunderstorms, it is usually safe to fly between the thunderstorm clouds; but one should be prepared to encounter varying degrees of turbulence. In general it can be stated that the wider the clear spaces the less the turbulence and the narrower the clear spaces the greater the turbulence.

Flying through a thunderstorm in a mountainous region is very hazardous at all times since a sudden drop of a few thousand feet could easily mean disaster. Here it is usually safest to fly between or over the thunderstorms.

The same general suggestions apply to frontal thunderstorms except that,

(*Turn to page* 335)

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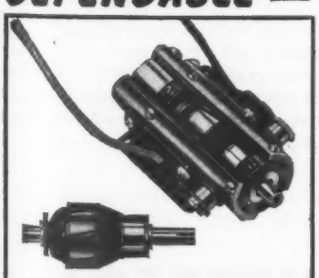

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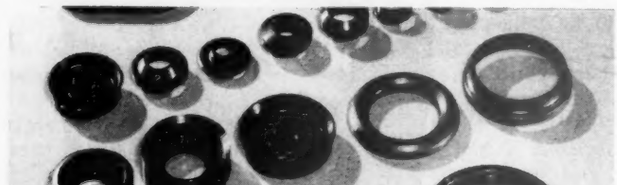

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due to the fact that severe turbulence frequently extends down to the surface, the hazard of flying through them is greater; therefore greater caution is necessary.

A pilot is asking for trouble if he attempts to fly into a thunderstorm when he is unable to tell into what portion of it he is flying.

Acknowledgments

I wish to acknowledge the help and valuable suggestions given by Mr. A. K. Showalter, especially with regard to the portion of the paper on evaporational cooling and wet bulb temperatures. I am also indebted to other members of the Hydrometeorological staff for their aid and useful criticisms, and to the drafting unit headed by Mr. W. E. Kinnear which is responsible for the fine drawings. (Figs. 4, 5, and 6.)

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Plastic Dies

(*Continued from page* 145)

and, at the same time, it allows for the rapid production that is not usually possible with a metal die. The Baker plastic has been used in making some blocks of the simple lay-over type and blocks in which the Acrylate sheet is held down with a ring. Long production runs have been made on form blocks of this type with no break-down, and no variation occurring in the die. The Acrylate sheets that have been formed on these form blocks have been better than were produced on form blocks of other materials, and, in some cases, have made possible the satisfactory forming of shapes that could never be formed before. The overall costs of these dies is lower than that of any other material except plaster or hydrocal.

It has been found most satisfactory to use a plastic containing an inexpensive filling material to reduce the cost of the form block. Several types of fillers have been tested and found satisfactory. Perhaps the best of these is walnut shell flour, although for some purposes, wood flour, diatomaceous earth, lamp black, carbon black, and in some cases, small amounts of sand, have been used. The main disadvantages of the fillers other than walnut shell flour are that they can not be used to the extent that it can. Sand is the only exception to this, and it has the disadvantage of producing a very brittle product.

The detailed process of making form blocks of this plastic material is as follows:

1. The pattern is made of plaster of paris or plaster of paris with modeling clay as suggested earlier. This pattern is coated with oil or other parting materials and the negative mold of plaster of paris is poured around the pattern. This negative mold is then lacquered with any good commercial lacquer. It has sometimes been found advantageous to put a thin film of wax on the plaster of paris mold before applying this lacquer film to facilitate easy removal of the casting. However, when this is done, the drying rate of the lacquer is frequently impaired and occasionally blisters may form in the lacquer before the plastic sets. It has been found that the plastic can usually be removed without using the wax. It is essential that the lacquer film applied to the plaster of paris be fairly heavy to decrease the danger of the plastic sticking to the mold. It is advisable to coat the mold first with a dark-colored lacquer until no white is visible, and then to apply a coat of light-colored lacquer to completely cover the dark film, and then to recoat with the dark lacquer to completely cover the light film. By following this procedure it is possible to consistently achieve a lacquer film of a satisfactory thickness.

2. After this film is thoroughly dry, the mold is ready to have the casting poured into it. If it is desired to produce the final plastic casting rapidly, the plaster of paris mold can be put in the oven at this point to pre-heat, care being taken to avoid its getting too hot and blistering the lacquer.

3. The volume of the mold is calculated, and from the volume the amount of plastic to be used is determined. About a pound of plastic is required for every 23 cu. in. of mold space to be filled. On the basis of the volume calculation, the desired amount of plastic is determined and weighed out.

4. The casting procedure involves mixing nine parts of the liquid resin with one part of catalyst, stirring gently until complete mixing is achieved. It is best to stir rather slowly because rapid stirring will mix air into the plastic and this may not all be released before it sets. After the resin and catalyst are thoroughly mixed, the filling material is slowly added and stirred in thoroughly. It is essential that the filling material shall not be added until after the resin and catalyst are mixed together, because there is always the possibility of some lumps forming in the filling material, and if this happens before the catalyst is added, the lumps will not contain catalyst and will form soft spots in the final casting. If the catalyst has been added first, the resin in the lumps will set and no soft spots will result. In the simplest molds, about 25 percent of the total weight of the finished plastic can be walnut shell flour; that is, 67 parts of resin and 8 parts of catalyst are mixed together, and then 25 parts of walnut shell flour are added.

5. After the plastic is thoroughly mixed, there is ample time in which to pour the casting. The plastic is poured into the warm lacquered mold. If any sharp contours occur in the mold, it is sometimes advantageous to carefully brush the plastic into them in order to remove any trapped air. The mold is filled and put into the oven at a temperature of 170 deg. F. to bake. No pressure is necessary. If the mold has been pre-heated, the baking time may be as short as two hours. The curing time is only two hours at 170 deg. F. provided it is possible for the heat to get through to the plastic, but is longer if heat transfer is low. For this reason, if a very large casting is being made so that the plaster of paris mold must have heavy wall sections, then the cure time of the plastic may be increased appreciably, in some cases being as long as six to eight hours. For instance, stretch press dies for metal forming using 300 lb. of plastic, have been made in plaster of paris molds. In this case, it was necessary to use a longer curing time, because the wall thickness of the plaster of paris mold was greater than 2 in. This resulted in slow heat transfer and a slow curing rate of the plastic. It is not possible to decrease the curing time by increasing the temperature, because at a temperature of about 190 deg. F., the plastic will start to boil during the setting process and the finished plastic piece will contain many large holes.

6. At the end of the curing cycle, the plastic can be removed from the plaster mold by the usual methods used in removing plaster of paris castings. If the lacquer film has not been applied heavily enough, it is possible that the plastic will be stuck to the mold, in which case it is usually necessary to break the plaster of paris off the die. After removing the plastic casting from the plaster mold, there is usually no clean-up necessary at all. If the lacquer film has stuck to the plastic, it can be readily washed away with acetone or lacquer thinner without harm to the plastic. For the forming of Acrylate sheets it is usually not even necessary to grind off the surface that was the open face when the die was molded. This exposed surface is often somewhat rough due to the bubbles that were stirred into the plastic and due to the meniscus at the edge of the mold. After any necessary finish-

ing, the usual felt cover is applied to the plastic die, and the die is ready for production.

The material cost of the plastic containing 25 percent of walnut shell flour is about 36¢. per lb. While this is more expensive than plaster of paris or wood, the labor costs for dies, per finished part, are usually less than with any other material, and production is not interrupted or decreased through the fault of the material used.

Subcontracting Policy

(*Continued from page* 189)

new equipment, what will you need in the way of help, to meet this schedule?" As William P. Gwinn, assistant general manager of Pratt & Whitney told AVIATION, such a program was set up because it was felt that the engine company could best expand by having the subcontractors expand at the same time.

This concurrent expansion represented a continuance of the corporation's long-standing policy of utilizing subcontractors. Pratt & Whitney—the engine division—has, in fact, farmed work out since its very inception.

Many of United's subcontractors have grown tremendously—one, for example, started work as a one-man shop—both in volume of work being done and the number of parts being produced. Nevertheless, the men charged with maintaining the subcontracting program still have plenty to do, especially in the follow-up work necessary to maintain the quality which is absolutely essential to aircraft engine production and delivery of quantities so as not to hold up final assembly of engines, propellers and airplanes.

Majority of this work is done by the purchasing departments which, when necessary, call in representatives of engineering or production departments to help iron out kinks that threaten to disrupt output. The very informality of the organization of the committee on subcontractors gives it unusual flexibility which has proved of inestimable value.

All preliminary educational work, which every subcontractor seems to require, is done in the corporation's own plants. After investigations by the division have indicated a potential subcontracting plant can handle a job, its key men are brought into the "parent" plant for training—for several months if necessary. United also gives the subcontractor every possible aid in securing the proper type of equipment so that adaptation of other machine tools will be eliminated entirely or kept to the lowest possible minimum.

Another P. & W. practice is to purchase all raw materials and make the necessary inspections before delivery to the subcontractor takes place. The divisions also place inspectors in some subcontracting plants as a means of saving time, material and transportation. These inspectors often serve as "secondary" educators, helping the subcontractor to produce work which will pass Army and Navy inspections.

This matter of rigid inspection often proves the greatest headache to subcontractors and many times it is cured only by the tough rule of "throwing rejects right back in their laps" until the work comes up to par. The value of insisting on such work—by Pratt & Whitney Aircraft and both services—has long since been proved by superior and unfailing performance of American combat aircraft on fronts all over the world.

While granting licenses to Ford, Buick, Chevrolet, Nash-Kelvinator, Jacobs and Continental has eased Pratt & Whitney's search for subcontractors, new organizations are still being added to the list. This is due primarily to the fact that engineering progress brings changes which call for new types of work on new materials. The increased power being developed by today's engines, for example, requires stronger bearings which, in some cases, call for new alloys. Thus, a hardware manufacturer which for years had been working with unusual alloys recently sent key men to United to go over plans and processes to determine what could be done to produce at least part of the requirements.

While the search for subcontractors has eased somewhat, there is every indication it will be continued for, as Mr. Gwinn points out, "This country, probably more than any other, has been one of specialists; it has a know-how that can't be found in any other country in the world. Therefore, it is only logical to profit by this experience which makes it possible to contract and buy on specifications."

Much the same system on subcontracting has been followed by the Hamilton Standard Division, credited by Vice-Adm. John H. Towers with producing "roughly three-quarters of the propellers required for combat planes and advanced trainers in our own war effort and, in addition, a majority of the propellers required for British planes."

In addition to requiring just as close tolerances as other branches of the industry, propellers as well as engines present additional problems in that balance becomes an outstanding factor.

It is impracticable for those without proper machines and skilled operators to attempt to manufacture precision parts in the quantities required day after day. It is not a question of making one part to the proper measurements—it is a question of turning out these parts to the same exact measurements and making prompt deliveries to the main plant so that production schedules may be met without any delay.

The majority of those seeking subcontracting work are not equipped with precision machines adapted to work of this kind, particularly internal and external grinder and thread millers and thread grinders, while still others fail to realize the close tolerances required.

Counting such cases—which all involve time and money—it is estimated by United officials that only about one in every hundred potential subcontractors is ultimately awarded a contract. Principal reason, of course, is that they simply can't work to the close tolerances necessary. Many other shops, it has been found, lack one or two machines essential to complete a part, and proposed adaptation of others will not produce the required quality.

Lack of skilled labor—or labor of any kind—is also a serious deterrent to subcontract awards. Recently, for example, a potential subcontractor called on Vought-Sikorsky seeking several available jobs.

"How many men do you employ?" he was asked.

"Oh, none now, but I have a lot of friends in plants around here I'll take out and put to work."

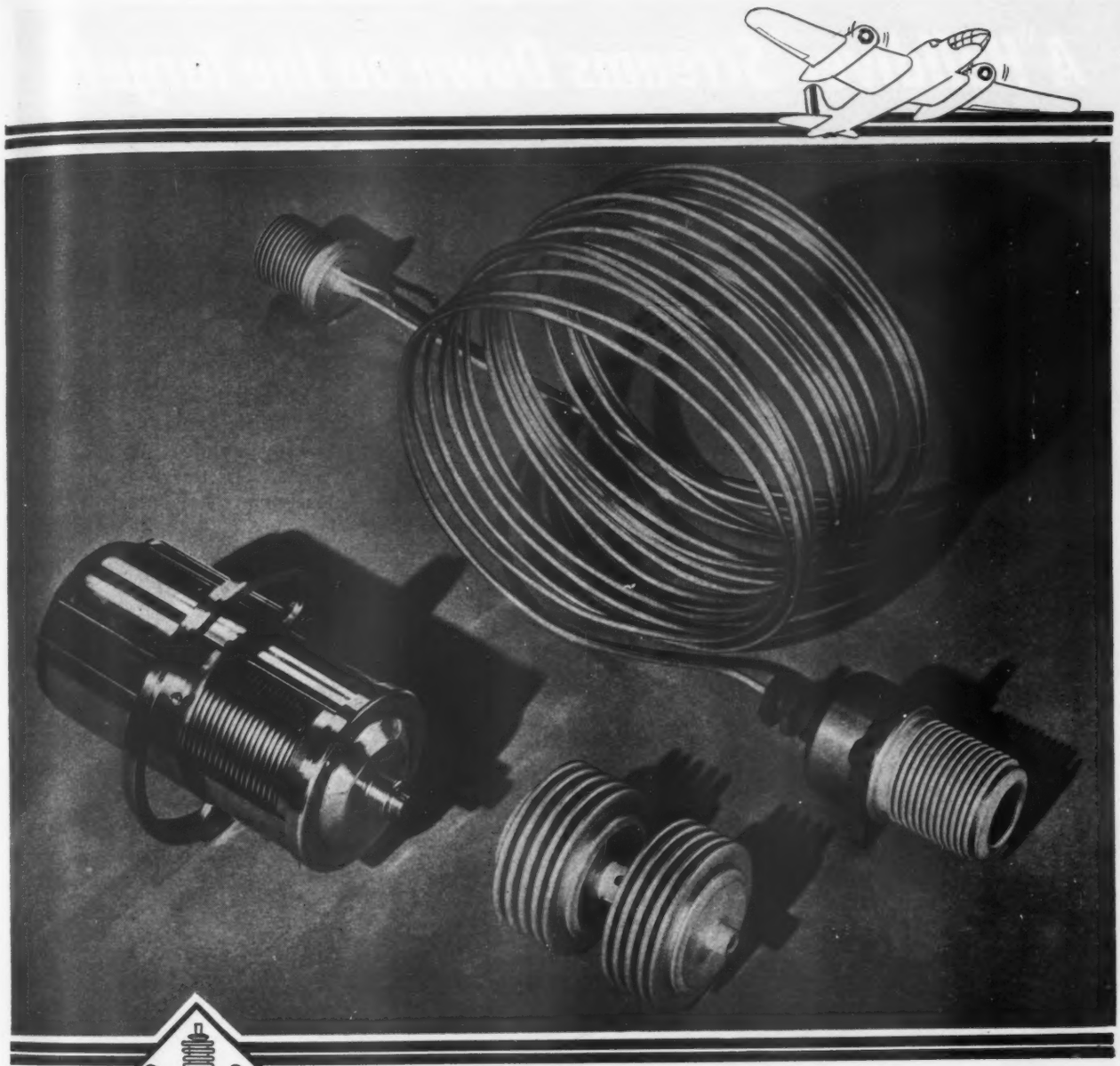
Since that would have meant raiding the ranks of both prime and subcontractors already working, and there was no way of telling when, if ever, he would have been able to get tools or a building in which to house them, he didn't get a subcontract.

In another case when Vought-Sikorsky trouble shooters went into a plant to see why the night shift had made practically no deliveries for three weeks they found the bottleneck at a simple milling machine operation. A few questions brought forth the information that the operator—up to three weeks prior—had been engaged in an unskilled line of work.

Despite the fact that only about one in a hundred potential subcontractors actually get work, Vought-Sikorsky's—as well as other United divisions—subcontracting is still on the increase. It has reached the point where complete wing panels are being built outside the plant by an automobile body company, with other subassemblies moving in from widely scattered parts of the country.

United has found—as have many other prime contractors—that subcontracting by subcontractors has not always proved satisfactory; the division of responsibility in pools has made it impossible to maintain production schedules which will deliver the quality necessary for combat planes, engines and propellers. In one such case, where the subsubcontractor had been picked

(*Turn to page* 339)



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Model of new Curtiss "Helldiver" (SB2C-1) Dive Bomber shown, courtesy of the Curtiss-Wright Corp., New York, N. Y.

SHELL

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(*Continued from page* 336)

by an outside agency, the work was so poor that United and its original subcontractor, who had been doing satisfactory work since the corporation's inception, both had to take over the operation to maintain a production balance.

And despite the constantly recurring headaches, there is every indication that subcontracting on a major scale will not only continue through the wartime schedule, but will figure as an integral part of postwar plans and production. As one official pointed out, "It worked well before the war, it's working now, it should work after the war."

For present and immediate future planning by potential subcontractors, however, one point is brought out which will help both the producer and those who would take on part of his work: it is to the advantage of both parties for the man wanting a farm-out job to list all cutting tools and gages, particularly odd sized or special equipment. In many cases such units may require minor adjustments, but with the prime contractor's know-how and knowledge of his requirements, they can be made to do a job which otherwise would go undone.

Piston Rings

(*Continued from page* 207)

this operation would destroy the choke features and its advantages. If any major cylinder reconditioning is necessary, the service department of the cylinder manufacturer should be contacted for detailed recommendations.

Pistons and Piston Rings

Before new rings are fitted, pistons should be thoroughly cleaned and all carbon removed from the piston ring grooves, and the oil drain holes in the oil ring grooves should be cleaned out. Care should be taken to prevent damage to the grooves during this cleaning operation. With the particular engine under discussion, the compression rings are wedge or vee shape and the engine manufacturer furnishes these rings in oversize widths of 0.002 in., 0.010 in., and 0.020 in. Under normal conditions appreciable groove wear does not take place, and if this is the case, new rings can be installed in the grooves after cleaning, providing they fall within the limits for side clearance shown in Fig. 10. In some cases, where the grooves are not severely worn, it is possible to use the 0.002 in. oversize rings in them without refinishing, providing the proper side clearance is maintained. In the event that the grooves are worn enough to require reworking, it is customary to cut the grooves oversize to the minimum oversize width necessary to clean up. Under no circumstances should the piston grooves be made deeper as this would seriously weaken the piston and ring lands. Care should be taken to preserve the radii in the bottom of the grooves. On wedge-shape grooves, a special tool is supplied by the engine manufacturer, together with a gage, in order to maintain the precise angle so necessary for proper fit. When pistons are regrooved to oversize width, this oversize should be in accordance with the manufacturers' recommendations such as 0.002 in., 0.010 in., and 0.020 in. Intermediate oversize rings are not furnished, and oversize rings should not be ground down to intermediate widths. Special grinding machines are required for this precision operation to prevent destroying the flatness of the rings.

Compression rings should be replaced at each overhaul. The dual oil control rings and the skirt ring may be carefully cleaned and used again if they show no appreciable wear or loss of tension. Wear can be determined by means of micrometers and loss of tension is indicated by reduction of free gap in the ring. It is advisable to check with a spring scale such as shown in Fig. 12 to determine the exact tension of such rings.

Gap or end clearance of the rings also serves to show the amount of wall wear (reduction of radial thickness) since the gap increases 0.003 in. for each 0.001 in. wear on the diameter. The gap opening is checked as shown in Fig. 13 by means of feelers, and both new and used rings should be checked by this method before reinstalling. By holding a gage of this type up to the light, a rough indication of the fit of the ring in the cylinder is indicated. In all cases, rings should be fitted to the end gap clearances shown in Fig. 10, and this clearance can be adjusted by carefully filing the ends of the ring and breaking the sharp edges with crocus cloth. If no ring gage such as shown in Fig. 13 is available, end clearance may be checked by placing the rings in the lower end of the cylinder barrel up against the end of a spare piston to insure that the ring is normal to the cylinder surface.

The piston ring arrangement for the engine under discussion is normally as shown in Fig. 10, but may be varied somewhat if special rings of cylinder materials such as nitralloy steel are used.

Lapping Piston Rings in Cylinders

In most cases, to insure quick mating of rings and cylinders, it is recommended that the rings be lapped in the cylinder barrel in which they are to be installed. This lapping will also remove the "oil glaze" from cylinders which have been in service, and improve the mating of rings and cylinders. The piston rings are normally manufactured with a turned and threaded finish on the o.d., and lapping should be carried out until these turn marks are removed and the surface appearance indicates complete contact around the periphery over the entire width of the ring. The number of strokes required to produce such a surface is dependent upon several variables, including the ring surface, the lapping compound, length of stroke, etc. A mixture of two parts kerosene to one part of Clover 2-A lapping compound has been used with good success. It is customary also to use a 0.010 in. oversize piston for the lapping operation to give a better guide to the rings during the lapping operation. In cases where an oversize piston is not available, a lapping plug can be made up to a skirt length equivalent to that of a conventional piston. The piston or lapping plug should fit snuggly in the cylinder to assure proper alignment for lapping the rings and to prevent the rings rocking, thus causing them to become crowned or barrel faced on the o.d. Used rings which are to be reinstalled should also be lapped as otherwise the polished surface will not readily make a new seat against the cylinder. After the lapping, rings and cylinders should be thoroughly washed in kerosene, and any feather edges on the rings should be removed with a fine stone or crocus cloth, care being taken not to form a radius on the edge of the ring. Any rings which show an irregular contact pattern on the periphery should be discarded as this is an indication that the ring has been bent or distorted.

When installing the rings on the piston, care should be taken to guard against twisting or distortion. After the rings have been installed, the side clearance of each ring should be checked, and for the engine under discussion, these limits are shown in Fig. 11. When checking the side clearance of wedge type rings, the outer face of the piston rings should be held flush with the surface of the piston, and the side clearance measured between the top of the piston ring and the piston groove. This clearance should be checked at several points around the periphery. The piston and ring assembly, before installation into the cylinder, should be dipped in regular engine oil and the rings compressed with a ring clamp to prevent damage during installation. As mentioned at the beginning of this article, these "bits and pieces" are vital to satisfactory engine performance, and they require careful handling throughout all the fitting and assembly operations to retain the precision originally built into them by the piston ring manufacturer.

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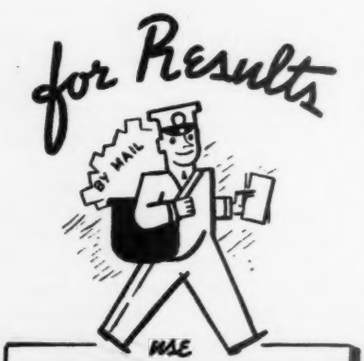

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Plywood Structures

(*Continued from page* 117)

Any suggestion that plants so equipped consider producing wood aircraft involved a major reeducation of design departments and substantial retooling of the shops. While the more advanced companies have gone so far as to organize nuclear design groups competent to handle wood structures, real attention was not given to wood aircraft until the metal shortages became severely restructive. It is now apparent that a substantial number of the aircraft required under the present program will be so constructed, and the current scramble for design information is the result.

The construction of wood airplanes is infinitely simpler than in a corresponding metal airplanes. The wood is much easier to assemble into a clean, smooth article (Fig. 6), and the number of wood craftsmen available and competent far exceeds the metal trades. Additionally, it should be recognized that the principal plants using wood and wood craftsmen during peacetime have fallen under the bans of war production, thus throwing into ready availability both the machines and the men needed for wood aircraft.

Drop Hammer Operations

(*Continued from page* 121)

From a finished and correct part, trim lines are placed on the inside of this galvanized trim template. The template is then trimmed along these lines and now can be used to make all parts.

Although it is the opinion of many people that the use of drop hammers brings with it excessive scrap, this impression is erroneous and is due to the fact that the excess material is trimmed off of the parts after forming so that it is visible to the casual observer. In other methods of manufacture, such as with steel dies in a punch press, this material is removed prior to forming. Actually only a certain area from any sheet of material can be utilized for forming of parts and the remaining portion becomes scrap.

Navy Alters Air Technician Requirements

The Navy has altered its enlistment requirements for qualified aviation technicians to permit such men to enlist and continue their course of instruction. Aviation mechanics, metalsmiths, ordnance men and radio men between the ages of 17 and 28 will be granted deferment from active duty up to three months to complete courses.